POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIII. CHICAGO, MARCH 1, 1919 No. 5

Engineering for Education

NEW ISOLATED PLANT SUPPLIES LIGHT, HEAT AND POWER TO DEERFIELD-SHIELDS TOWNSHIPS HIGH SCHOOL; TRANSMISSION LINES CARRIED 590 FEET THROUGH UNDERGROUND TUNNEL

DUE TO THE ever increasing demand for education, community growth is, as a rule, bound to be accompanied by increased local educational facilities, and as the smaller towns and even villages do by no means suffer from a lack of schools of the primary and secondary grades, so we find but few of our larger cities which do not have their universities and other institutions of advanced learning. This is particularly true of the more densely settled centers of population, and even here the outlying suburbs are not prone to depend upon the city for the education of their young, but provide schools and academies which in many instances offer courses of study comparable to those offered by the institutions of the neighboring metropolis.

As a typical instance we may cite the case of the Deerfield and the Shields Townships, Lake County, Ill., which, although within half an hour's ride of Chicago, have at Highland Park one of the most modern and fully equipped high schools in the middle west. This school, known as the Deerfield-Shields Townships High School, consists essentially of five distinct buildings, two devoted to class rooms, one to the gymnasium, one to the industrial arts and sciences, while the fifth, set back somewhat from the group formed by the others, is the power house, used to serve the institution with electric energy, steam, hot water and air.

FIG. 1. INTERIOR OF ENGINE ROOM, DEERFIELD-SHIELDS TOWNSHIPS HIGH SCHOOL

As will be noted by reference to Figs. 4 and 6, the building housing the steam and power generating equipment and auxiliary apparatus comprises a boiler room and adjoining engine room, with the floor line of the

latter about 14 ft. above that of the boiler room. It is a fireproof structure of steel, concrete and brick, having overall dimensions of approximately 50 by 74 ft., and with both exterior and interior architectural features of plain but pleasing appearance. Outside walls are faced with rough red brick, while the interior walls of the engine room, except for a 6-ft. wainscoting which is of a tan color, are painted a light cream. The same color

FIG. 2. GENERAL VIEW OF BOILER ROOM

scheme is employed in the boiler room, although here, in order to neutralize the effect of the coal and ash dust bound to find lodging on such surfaces, side walls for a height of about 6 ft., boiler setting walls and pipe covering have been made a dark green; the metal work, such as stairs, railings and exposed pipe fittings, is in black.

A noticeable and valuable feature is the excellent degree of natural illumination available, provided by

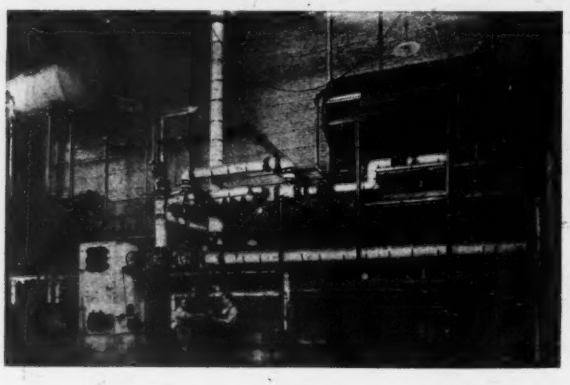


FIG. 3. VIEW IN BOILER ROOM SHOWING HOT WELL, HEATERS AND BOILER FEED AND VACUUM PUMPS

means of large windows placed in all of the outside walls of both boiler and engine rooms.

Steam-Making Equipment

Due to placing the power house on a decided slope of ground, and the general arrangement of building employed, the coal storage and handling question resolved itself into a comparatively simple problem. By means of an extension of the boiler room foundations a distance of approximately 26 ft., and providing a suitable covering fitted with eight 1-ft. 10-in. coal holes, a storage bin having a capacity of about 300 tons of coal was provided. Wagons and trucks delivering this fuel are, due to the fact that the top of the bin is at the same elevation as the roadway, capable of driving directly over any one of the coal holes and discharging the fuel directly into the bin below. From here the coal is shoveled into one ton cars which, after being weighed on a 3000-lb. beam scale, is placed in front of the boilers within ready reach of the fireman.

Trucks and wagons before being dumped are also weighed, a five-ton scale having been provided for the purpose.

Steam is employed for the generation of electric light and power, the heating of buildings and natatorium tank water, and for such other services as required in

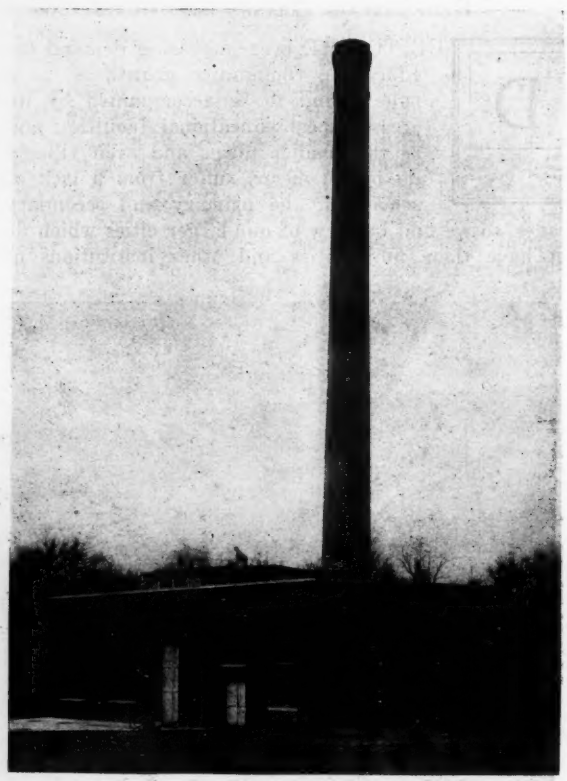


FIG. 4. EXTERIOR VIEW OF POWER HOUSE

the laundry, the cafeteria kitchen and the domestic-science department of the institution. The boilers which provide this are two in number, each of water tube type, having a rated capacity of 271 hp. under a normal working pressure of 80 lb. gage. They are set in a single battery and are provided with uptakes which connect with a common sheet metal breeching at the rear and tapering in section from about 3 by 4½ ft. to approximately 6 by 4½ ft. at the stack, thus allowing nearly 33 sq. in. of breeching section per rated boiler horsepower. The stack, a structure of radial brick, has an internal diameter of 6 ft. and a height of 150 ft.

Boiler makeup is taken from the local city mains at a pressure of from 40 to 50 lb. gage. Service is through a 3-in. line with connections such as will allow this water to be fed directly to the boilers, to an open feed water

heater rated at 700 hp. or to an overhead hot well, a steel tank having dimensions of 5 by 8 ft. and located directly above the boiler feed pumps as indicated in Fig. 3. The line connecting with the hot well is tied in with a 4½-in. main which carries the discharges from the two vacuum pumps placed to the right of the heater.

With the scheme of connections employed, the water flows by gravity to the heater, from where, after it has attained the desired temperature, it is delivered to the boilers by means of either one of two 7 by 4½ by 8-in. duplex pumps, having 4-in. suction and 3-in. discharge connections. Control of pumps and regulation of feed is done entirely by hand.

Steam leaves the boilers through 6-in. connections tying in with a 10-in. header, which in turn is joined to a 9-in. riser feeding a main distribution header of like size. At a point near the wall separating boiler and engine rooms, this header is divided, one branch of 6 in. being carried into the engine room, while the other, 8 in. in diameter, through the medium of a pressure reducing valve and the bypass arrangement shown in Fig. 6, joins the main exhaust line leading to the various buildings.

switchboard shown at the left of Fig. 1, which consists of three black slate panels. One of these panels is for the generator, the middle one for distribution and the third for the carrying of the various steam, water and air gages.

The only other equipment installed in the engine room is a motor-driven vacuum cleaning machine and a 6 by 4 by 8-in. simplex steam-driven air pump and receiver used to supply air at a pressure of 15 lb. gage for the operation of the ventilator dampers in the various school buildings. The steam supplied to this pump is under automatic control, the air in the tank acting on a diaphragm valve which as soon as the pressure drops to 14 lb., opens and allows the pump to take steam; with a pressure rise to 15 lb., the steam is cut off.

Steam Distribution

Under normal conditions, as stated above, exhaust steam is used for heating purposes. That coming from the engine, after passing through an oil separator, is discharged into an 8-in. main connecting with the heating system and provided with two outlets, one to the

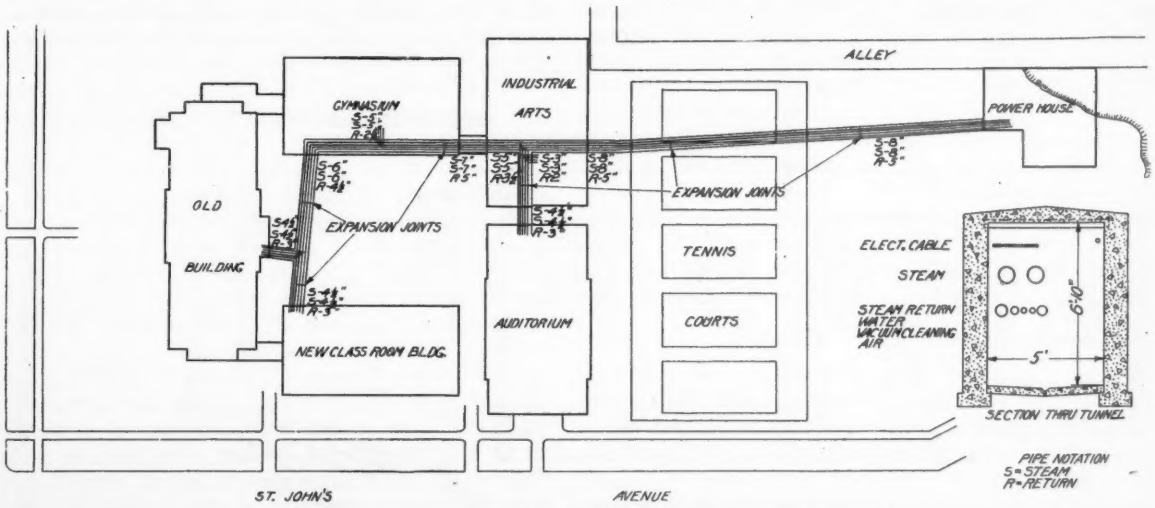


FIG. 5. GENERAL LAYOUT OF BUILDINGS AND TUNNEL SYSTEM

By this means it is possible to supply live steam to the heating system in the event the engine or none of the pumps are in operation, or should the supply of exhaust be insufficient to meet the demand such as may arise during severe winter weather.

The pumps receive steam through a separate supply line, 2½ in. in diameter, and may exhaust either directly into the heater or the heating main. The engine exhaust, a 6-in. line, connects directly with the 8-in. heating main.

In the Engine Room

Shown in Fig. 1 is an interior view of the engine room, which, as may be seen, is at present equipped with but a single prime mover, although space has been provided for a second generating set of like size should at any future time load demands warrant the installation of such. The engine, a 112-hp. unit, is of the automatic high-speed type, having cylinder dimensions of 13 by 14 in. and is direct connected to a 75-kw. three-wire direct current generator.

Current is delivered to and distributed from the

heater and the other to the atmosphere through the medium of a 7-in. riser fitted with a back pressure valve and an exhaust head located above the roof of the boiler room.

Two 8-in. lines are employed to conduct the steam to the buildings comprising the high school and, like the heating returns, water, air, vacuum cleaning and electric lines are carried through a tunnel, sectional view of which is illustrated in Fig. 5. This tunnel, which is of reinforced concrete and has sectional dimensions of approximately 5 by 7 ft., rests upon footings carrying 1-ft. side walls joined by a roof, also of concrete, having a maximum thickness of about ½ ft. and reinforced with rods and I beams which also act as points of suspension for the pipe hangers. These consist of drop rods, the lower ends of which are fitted with cross pieces made of piping and while not providing a rolling bearing reduce to a minimum the resistance offered any longitudinal movement of the piping caused by expansion and contraction. Each of the pipe lines is, in addi-

tion, fitted with a slip type expansion joint, one of which is inserted about every 125 ft.

The tunnel, as may be seen by reference to Fig. 5, leads from the power house directly to and under the Industrial Arts Building, at which point 5-in. steam branches and a 3½-in. return branch are provided to serve this building and the proposed auditorium. The Industrial Arts Building is served by two 3-in. steam lines and a 2-in. return.

From here the tunnel is continued through the base-

TABLE I. DIRECT AND INDIRECT RADIATION EQUIPMENT AT DEERFIELD-SHIELDS TOWNSHIPS HIGH SCHOOL

Building	Square Feet Direct Rad.	Square Feet Indirect Rad.	Make and Size of Fan	Size of Motor Driving Fan
Gymnasium	2000	1511	#11 Sirocco 51,000 cu.ft.per min.	15 Hp.
*New Class Bldg.	600	4522	#12 Sirocco 80,000 cu.ft.per min.	15 Hp
Industrial Arts	1577	772	#7 Sirocco 16,000 cu.ft.per min	7½ Hp.
/Old Class Bldg	1060	2800	140 in.- ¾ Housing 30,000 cu.ft.per min.	
Boiler House	200			

*Two upper floors not finished - no direct radiation installed
/Indirect system made up of 1-in. piping - originally heated by blast

of about 70 deg. F. is maintained, and in order to provide automatic regulation, the tempering coils used in connection with this equipment are under thermostatic control, thus allowing the operation of only such number of tempering coils as may be required to maintain the desired temperature. Number of square feet of direct and indirect radiation, and sizes of fans and their driving motors employed in connection with the heating system are as enumerated in Table I.

Returns from the heating system are brought back to the power house through a 5-in. line carried along the east boiler room wall, where by means of the proper connections they are tied in with the suction of the vacuum pumps, two 8 by 12 by 16-in. units, which in turn discharge into the hot well.

Hot Water Service

For all purposes except the heating of the water used in the natatorium there is installed in the boiler room, as shown in Fig. 3, a hot water heater of the closed type having a capacity of 1500 gal. and capable of supplying 50 gal. of water per minute. This water is heated by a steam coil automatically controlled and while ordinarily the steam employed for this purpose is

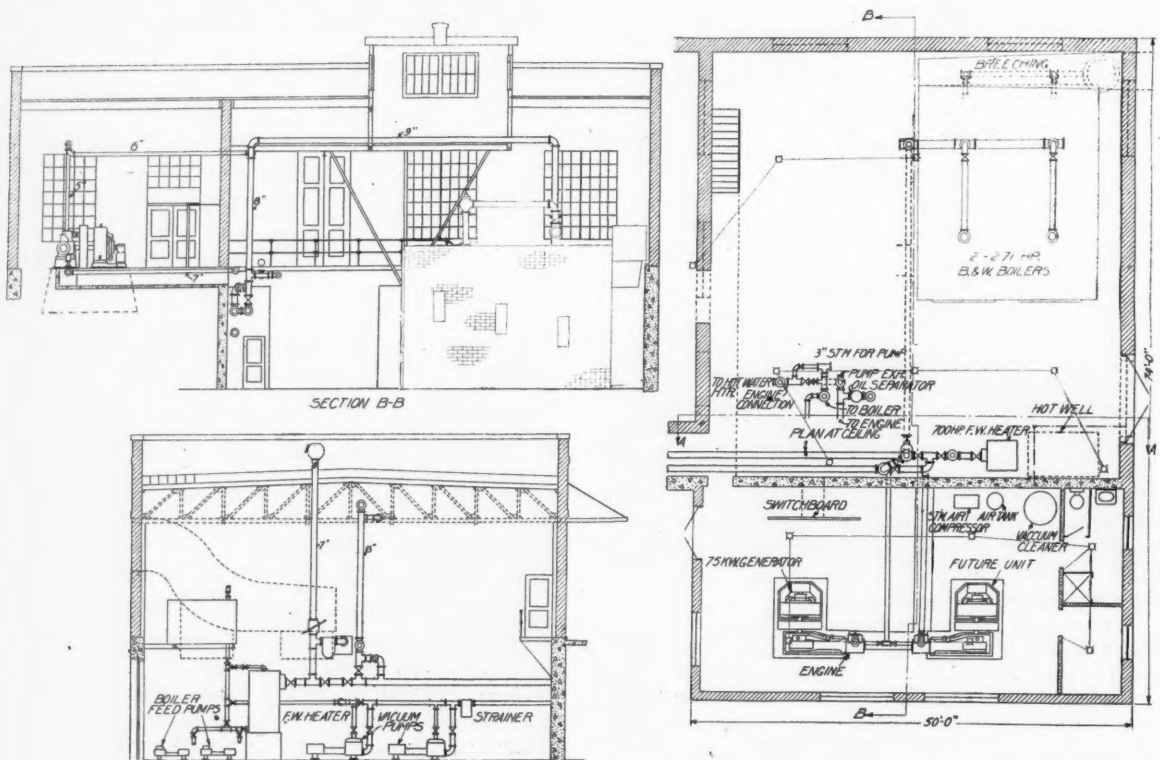


FIG. 6. PLAN AND ELEVATION OF POWER HOUSE

ment of the gymnasium, and thence to the old and new class buildings. The steam lines serving the gymnasium are each 5 in. in diameter, while a 2½-in. line is used for returns; each of the other two buildings is served by 4½-in. steam and 3-in. return lines.

Direct and indirect radiation are employed in all of the buildings, except the power house, where only the direct system is used. Ordinarily a blast temperature supplied by the boilers, a 42 by 48-in. coal heater is installed, and so connected that hot water is available even though the boilers may be shut down, as they are during the greater part of the summer months.

Makeup for the hot water system is taken from the city mains, and is maintained in circulation by means of a 2½-gal. motor-driven centrifugal pump having a rated capacity of 150 gal. per minute.

A twin jet heater of the air conditioning type employing a 6-in. water supply and a 5-in. steam supply is used for the heating of the natatorium tank water, maintaining this under ordinary conditions at a temperature of 78 deg. F. The water, which is introduced at the shallow end of the tank is circulated both for heating and filtration through 6-in. pipes, the water leaving the tank through openings on each side at the lowest point of the tank. Circulation is secured by means of a single stage centrifugal pump operated by a 5-hp. electric motor, and before being reused is caused to pass through a pair of filters and purifiers. Filtering is accomplished by beds of gravel and charcoal, while chemical process is depended upon for purification.

The swimming pool has overall dimensions of 24 by 60 ft. with a maximum depth of 8 ft.; the steam used for the heating of the water is transmitted from the boiler room at a pressure of 80 lb. through a 2-in. line.

Engineering and architectural work in connection with the Deerfield-Shields Townships High School was done by J. C. Llewellyn of Chicago, to whom, together with J. H. Morse, chief engineer of the power plant, we are indebted for information and data making possible the preparation of this article.

Steam Turbine Operation

POINTS TO BE WATCHED, AND CONDITIONS TO BE SOUGHT FOR BEST ECONOMY. BY J. B. WILSON

IN THESE days when power plant apparatus has grown to such enormous size and when, in the rapid march of progress, new and more efficient designs have been evolved, it is well to consider some of the troubles which have been or are likely to be experienced with such apparatus, and more particularly the precautions that should be taken to avoid these troubles.

A manufacturer must design and build steam turbines, as nearly as possible, to fit some given conditions that may be considerably different than the final ones. He, as well as the purchaser, has many uncertainties to contend with which, with the human element, prevents ideal performance all of the time. If the assumption of conditions and design, as well as the manufacture and application, are well handled, the amount of trouble and maintenance will be relatively low, and the apparatus generally satisfactory. This assumes average handling of the apparatus in service, for even if a fine machine, the dissatisfaction will be too great, if the required skill in handling is such that men cannot, with reasonable ease, be obtained who have the required skill, or if the obtainable men cannot readily acquire it. If the skill required is reasonable, it is even then certain that some units will be operated by men without the required amount, and this is written to pass on some information to those to whom it may be of value. Necessarily, however, it is general and should be examined carefully, if you have a particular situation in mind, for it might not apply in that case.

Turbine speeds ranging from 30,000 to 1500 r.p.m., and lower, are common, and while these at first glance seem quite high, a further consideration reveals that the velocity of the blade tips is more important. It is also known that slower speed units with large diameter rotors have proved their factor of safety to be lower than the higher speed ones. Some other factors enter in, however, such as the temperature of the different parts, their fits, and the material used.

YEARLY EXAMINATION

IT IS good practice to examine, adjust, and repair turbo-generators annually, as this usually keeps them in shape without further work on them except the handling in service, but as conditions may force attention at other times, it is desirable to know the temperature, pressure, etc., normal for various conditions, observing, recording and analyzing these regularly in order to act should the safety, reliability, or efficiency become impaired enough to justify action. Often too little attention is given, although, while it is the decided exception, too much has in some cases been given, largely due to adherence to a poorly planned examination schedule. Care is desirable but should bring efficiency in its largest sense in the plant as a whole.

The usual minimum longitudinal clearance of turbines at the working face of impulse blades is 1/8 in., while the usual minimum radial clearance of reaction blades is 0.035 in., both amply sufficient, yet the former harder to hold as wear in a thrust bearing or misadjustment is much more liable to shift a spindle endwise than anything is to shift it up, down, or sidewise.

PRESSURE AND SUPERHEAT

THERE is a tendency to go to high steam pressure to get high efficiency, yet it is not clear how high we can go and not exceed the point where the greater capital and maintenance cost equals the amount saved by the lower fuel cost. The tendency with superheat is to lower it as the pressure goes up in order to keep the total steam temperature within limits suitable for the usual steel parts. In the average plant 150 to 200 lb., and 100 to 150 deg. F. superheat represents good practice.

With the usual 150 lb. gage pressure at the boilers, the turbines should be designed for about 140 lb., as about a 10-lb. drop in the piping is normal. If the drop is less, pressure is conserved, but the capital and condensation losses are higher. While a drop of 25 lb. with a boiler pressure of 350 lb. is about right, considerable complication may result with this drop on lower pressures and variable load, especially when superheat is used. On a rapidly and severely changing load, almost full pressure may reach the turbine with the superheat lost by radiation when the load is light, while on an increase in load the superheat will rise and the pressure fall at the throttle possibly considerably, curtailing the capacity.

In an existing plant there is a proper drop between the boilers and throttle for different steam flows, which the men should know, for occasionally the drop becomes excessive from choking.

There is a normal difference, usually 10 to 20 deg. F., between the incoming and outgoing water temperatures

at the oil cooler. Any change indicates more heat to be removed from the oil, a dirty cooler inside or out, or a lower water flow.

Lubrication

In the oil at a main bearing the usual normal difference is also about 20 deg. A rise indicates extra duty on the bearing, an impairment in the oil quality, or a decrease in the flow through the bearing.

One of the principal duties of the oil is to carry the frictional heat to the water, the amount of flow, therefore, being vital.

Outgoing oil temperatures of 140 to 150 deg. F. are common, and, while some oils safely stand higher temperatures, if a unit has a higher oil temperature, extra care should be used to select a suitable oil, also in looking after the oil and cooling system.

If a unit vibrates abnormally, it may be that reducing this will lower the oil temperature.

Oil ordinarily gravitates to the oil pump, and with the usual amount in the system this insures a submerged suction if the returns are kept reasonably free of deposit.

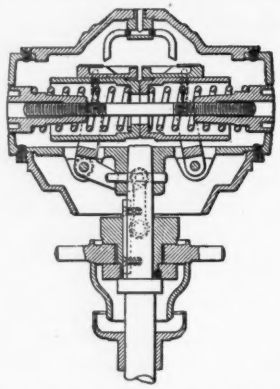


FIG. 1. DETAILS OF TYPICAL SPRING-LOADED TURBINE GOVERNOR

An oil pump requires little attention, but in time the amount of oil circulated and the pressure will decrease, forcing repairs. Decrease in pressure, however, may come from a bypass open, a cut bearing, a partially submerged suction, a valve acting improperly, or some opening between the high and low-pressure sides of the system.

Governors

Usually slow-speed worm-driven governors require little attention, assuming forced lubrication, except to keep down lost motion and dulling of knife edges, yet infrequently a governor spring breaks or becomes weak, requiring renewal or adjustment. The springs are usually equipped with shackles for increasing or decreasing the number of active coils in order to obtain the desired difference in speed between light and full load. Increasing lowers this difference or may remove it, but makes the speed on a given load less fixed, and, if carried too far, may cause vicious variations in speed which may or may not be constant. Decreasing the coils increases the difference in speed, but gives a steadier speed on a fixed load. The usual difference, no load to rated load, is 3 to 4 per cent, but should a given frequency be desired, as is often the case on a transmission system, the adjustment should be by means of either a hand or motor-operated auxiliary spring speed changer without change of the main spring adjustment. The usual range of these is plus and minus 5 per cent.

If the load on the governor linkage is constant, as is usually the case with relay operated valves, the speed change with equal load changes is fairly constant; but should the load on the linkage increase at some point, such as would occur if an incoming valve lifted by linkage was binding, this speed would have to decrease until the governor accumulated energy enough to make the lift, causing a non-uniform speed change. If you have 5 per cent regulation with most of the change occurring when various valves cut in, you may be unable to better it by spring adjustment without encountering racing. With relay type valves, provided the oil pressure is ample, this is avoided, but the timing of the cutting in and out is of great importance, with racing possible, if the relay is improperly machined.

The shackles permit spring adjustment to obtain like regulation in several units, also to extend temporarily the life of a weakened spring, yet lead to some trouble due to adjustment when the fault is not in the spring, although racing seldom is caused by the spring scale.

Wear or loosening of the parts in a governor drive may vary its speed so much that racing occurs. The usual worm drive has a good margin in its design, yet may be worn from an undue load such as a seizing bearing or some part of the governor rubbing on the frame. If on light load, the balls travel out, due to errors in adjustment, farther than intended, they may rub or hit. Some turbines have in their governor group a device which causes the valves in use to oscillate slightly in and out, not enough to cause racing, but enough to result in a freer operating valve, hence giving better regulation, especially when a change in load occurs after long operation on a fixed load.

Valves

Usual drop in pressure through an admission valve is 10 lb. on full steam flow, which flow should develop a normal load for a given unit and conditions. If the drop exceeds normal, the valve may be opening improperly. A common assumption is that when the stem has full travel, the valve has; but this is sometimes wrong, due to lost motion or even the loss of connection between valve and stem. If the drop becomes less than normal, other valves may be badly cut, not closing, opening early or partly only, without this being readily apparent. The valves are usually spring loaded, but with normal tension the spring may be too weak to force a bound valve shut. Mechanical interferences occasionally are encountered in old, badly worn, or remachined valves. Where valves are closed by gravity plus a slight unbalance, especial care to insure proper action may be required.

To get uniform speed regulation all the way on an ascending or descending load there should be only one admission valve and nozzle, the control being by throttling; but as this would fit few load conditions, multiple valves are usually used. This leads to some non-uniform speed change as the valves cut in and out, sometimes enough to be objectionable. With relay-operated throttling valves, and graduated ports, there is little diffi-

culty, and while throttling valves direct on the linkage necessarily cause some uneven speed, this should not be enough to be objectionable if kept in proper condition. Where a valve of relay type goes wide open when it starts to open, the speed must rise rapidly, which will cause the governor to close the valve, resulting in a rapid speed drop, repeating indefinitely. The viciousness of this racing may be hard to control if a few large valves are used with only one turbine operating.

If a valve when seated is unbalanced, considerable effort may be required to lift it off its seat, which is liable to cause it to overtravel, leading to an improper speed change. As it goes onto its seat, the speed may also be affected. Such unbalance usually is the result of uneven bedding of the valve discs into their seats from wear or poor machining.

If a valve is used much barely off its seat, wiredrawing of the steam may lead to cutting; hence if a slight

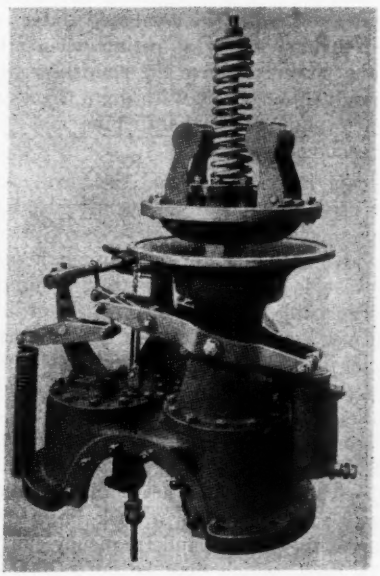


FIG. 2. TURBINE GOVERNOR EMPLOYING SPRING BEARING DIRECTLY IN GOVERNOR SLEEVE

shift of the load balance between units is permissible, that may be desirable in order to prevent the wiredrawing.

Some disc valves have wings on them with graduated ports, while others are of piston type with straight ports and while alteration of the ports may be desirable, it should not be done unless the proof of the need is clear; that is, it is reasonably certain that the fault is not elsewhere. If the first valve is cut, or does not seat properly, overspeeding may be in evidence on no load and full vacuum, or a near approach to this. Usually the temperature of the unit when shut down, the issue of steam from the free exhaust pipe and the valve action on no load, indicates the amount of impairment. With valves in parallel, the impairment may be in any one or all of them, and is more serious in the others, as on load the steam passing through a valve which should be closed and tight is not used economically.

Frequently turbines are operated with steam temperatures greatly in excess of that for which they were designed, and occasionally have valve trouble due to the material not being suitable for the new conditions.

There is a normal load capacity for each control valve and nozzle which it is well to check periodically in order to keep the apparatus in shape and not cut in another valve or nozzle earlier than needed. We would not consider starting up an additional unit unless those operating could not safely carry the load existent or about to come on, and to obtain the best efficiency the same attitude regarding the cutting in of a valve before it is needed is desirable.

Where a second or third valve bypasses part of the blading, and the inlet pressure approximates the available pressure before the capacity reaches the point where the next valve should open, it may indicate a reduction in the openings through the unit which may or may not have been intentional. Occasionally these are changed to shift the most efficient point. Through the unit there should be a normal pressure in each stage for a given load which should be checked occasionally as it gives a warning, if the passages are altered as may occur from cutting or choking of nozzles and blades.

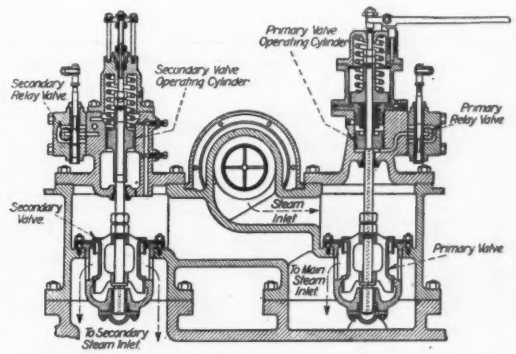


FIG. 3. TURBINE VALVE GEAR WITH STEAM RELAY

If the steam is wet, and the velocity high, the tendency is quite the reverse, causing choking from material carried over in the steam, and while the usual designs avoid the cutting, underloading may result in deposits. Obviously, the fault is in the steam, yet if it cannot be overcome, periodic cleaning by scraping or slushing may be necessary as the deposit may affect the thrust capacity and efficiency.

Blade Loss

While blade loss with modern machines is unusual, it is possible to lose light ones, even rows of them, with little commotion, in which case about the only immediate evidence is an alteration of the pressure drop through the unit on a given load. Loss of heavy blades is usually apparent from the commotion and vibration which may be severe enough to force taking the unit out of service. Vibration may come from causes other than unbalance, among them being misalinement at operating temperature, rubbing of parts unlubricated or inadequately lubricated, loosening of parts at speed, critical speed, part of unit unsupported or strained, loose bearings, and pipe strains.

Pressure Drop

Some units are equipped with steam strainers which may become choked, causing an undesirable pressure

drop which, in an exceptional case, may be sudden and severe, seriously affecting the capacity. Where the feed water is treated, or where considerable packing comes over in the steam to a low pressure turbine, choking may force frequent cleaning.

It is useless to produce a higher vacuum than the turbine will utilize, and should this limit be adhered to, the drop in pressure from the last row of blades to the condenser is usually low unless the connection is long. This may be of great importance, for a ½-in. drop over the usual 0.1 to 0.2 in. may mean 2 per cent added to the turbine water rate.

While most of the late large units can utilize 28.5 to 29 in. vacuum at rated load, many existing ones can only utilize 28 in. and some only 26 in.

Exhaust Heating

Many outgrown condensing units are run non-condensing in the winter, exhausting into a heating system on the basis that as all the exhaust is utilized, the efficiency is immaterial. Often this is in error, for should the turbine be altered, as may be easily possible by removal of blades, and alteration of the steam passages, the load developed on a given amount of heating should be increased, leaving less to be carried on the condensing units, thus decreasing the coal consumption of the plant.

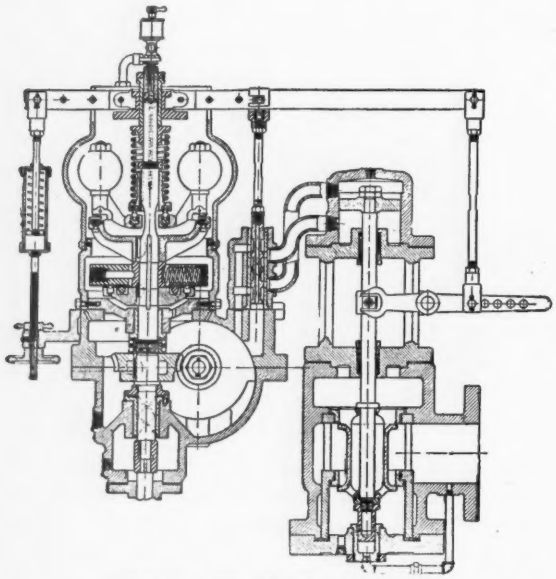


FIG. 4. OIL RELAY GOVERNOR

As it is impossible, using one unit, to obtain a continuing balance where the exhaust resultant from the load carried just meets the heating demand, many compromises are used. The most satisfactory scheme is separate units holding the load on the non-condensing one to obtain the heat desired. Compromises, such as bleeder or extraction turbines, are used with quite beneficial results under some conditions, but the handling on variable loads must be of the best or the economy may be much less than is possible.

If the steam is extracted at low pressure, it contains considerable condensate, hence the weight must be discounted when compared with high-pressure steam whose heat content is higher.

At some combinations of load and heating it is more economical to extract no steam, getting the heat from steam direct from the boilers, or to run a straight condensing unit obtaining the heat direct as before. If the heating is quite heavy, the capacity of the unit may be low, while if it is quite low, the capacity may be so large that the generator may be overheated unless care is used.

The usual governor with a given change in speed gives a certain valve change, resulting in a certain steam flow change, all harmonizing with the load on a condensing unit; but on an extraction unit the speed will change on a change in flow through the extraction opening, even if the load is constant, and under some conditions this may make extraction inadvisable.

If the load does not increase and decrease with the heating, consideration of the other possibilities in the unit and plant are advisable.

Few low-pressure or mixed-pressure turbines are being purchased now, for usually their usefulness depends on an engine, and while the combined water rate of the engine and turbine is low at rating when allowance is made for the power to drive the condenser, it does not appear so advantageous. With light load it may be economical to shut down the turbine and operate the engine non-condensing.

Live steam used in a mixed pressure unit is ordinarily not used economically. Its use also impairs the regulation, and this may force passing it through a reducing valve into the low-pressure main at a rather poor relative efficiency. The greatest complication is a deposit, largely oil, on the blades which, ordinarily, can be cleared out by a suitable dose of kerosene admitted rapidly and in such a manner that the liquid reaches and scours the blades. Admitted slowly, it may add to the complication. The effect of scouring is usually plainly observable, as the inlet pressure necessary to carry a given load drops when the scouring is effective. If the deposit has been long accumulating, one scouring per day may be advisable for a week, but after the blading is cleared, the amount and frequency can be reduced to suit the need, which may be on a 1000-kw. unit a 1 gal. dose once a week or month.

Glands

Spindle glands must hold and while the attention needed is small except to adjust the steam pressure on the steam-sealed type, dirty steam or vibration may damage the steam-seal type while sand in the water may cut the water-sealed type. If the sealing water is hard, lime may form in the water sealed type, but almost never to an extent requiring attention other than in the annual overhauling. It usually can be decreased by establishing a flow through the glands, or avoided by using soft water or condensate. In rare cases, burning out the pipes and parts with acid may be advisable, as it often is with cooling coils buried in bearing babbit.

Abnormal vibration in a unit may force renewal of diaphragm packing in order to avoid the loss resultant from excessive clearance.

Steam Economy

It takes a certain amount of steam to run a unit without load; then the water rate per kilowatt will lower as load is added until the capacity on the first

valve or nozzle is reached when there will be an abrupt impairment as the next valve or nozzle comes into service, repeating as additional valves and nozzles act, and while ordinarily satisfactory, it may be possible to better the limit on the load carried by a change in the capacities of the various valves and nozzles. You may be interested greatly in the water rate at 80 per cent or 60 per cent rating and little interested at the arbitrary points, ¼, ½, ¾ and full load, these being largely merely retained from old engine practice.

Some well selected units have their most efficient point at 50 per cent of rating, others at 60, 80, or 100 per cent; clearly, it should be at the point giving in service the best all day or year efficiency and not at some load never carried except momentarily.

A study of the total steam curves may show that it is desirable for economical as well as practical reasons to carry the load on a given unit at some fixed point, letting another unit do the regulating.

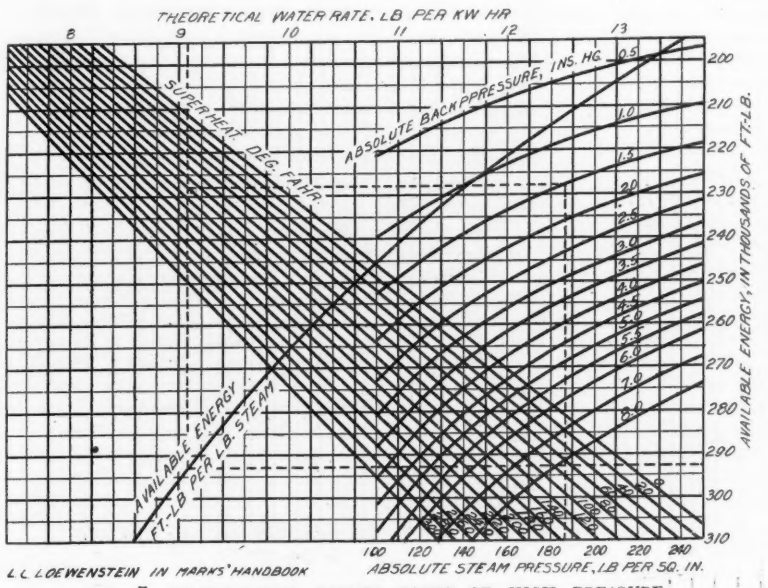


FIG. 5. THEORETICAL WATER RATES OF HIGH PRESSURE CONDENSING STEAM TURBINE

Turbines are usually guaranteed on the basis of pounds of steam per kilowatt-hour, while it appears that the total steam per hour on the various loads is better as a comparison between units, for with such a curve based on two points per valve as known from the Wilans law, the rate at any load should be easily ascertained and is much more reliable than from a curve based on the rates per kilowatt-hour. A smooth curve drawn through the points guaranteed on the pounds per kilowatt-hour basis is seldom correct at intermediate points.

Comparison of water rates of different plants is liable to lead to quite improper assumptions unless due allowance is made for local conditions and load character as well as the apparatus, but a critical comparison of the efficiency actually obtained from a unit with that guaranteed is highly desirable. Turbines have for long periods given efficiencies higher than guaranteed, and should the actual results be much worse, the chances are that a study will reveal the cause, which can be largely eliminated.

There is a normal pressure, temperature flow, etc., at every point in the unit and plant for a given set of conditions. Can we not by education, curves, tables, equipment, and the like, so arrange it that the men can and will know when an abnormal condition sets in and act to stop it when it becomes bad enough to justify the time and expense? This will tend to elimination of real trouble, to keeping down of maintenance and the keeping up of the plant efficiency.

"The Voice With the Smile Wins"

THE WAY you meet and greet a fellow worker can make a friend or enemy of him. You know that. But do you know that if he is a foreigner it can do more? It can make him more friendly to America. Why? Because the foreigner must judge America mainly by the Americans he meets and the way they greet him. Put a smile in your voice. Don't make "good morning" sound like "bad cess to you."

APPROXIMATELY four million officers and men of the Army and Navy are now insured with the United States Government for a grand total of almost thirty-seven billion dollars. It is the strongest, safest and cheapest life insurance ever written.

For the protection of these men and their families Uncle Sam has established the greatest life insurance company in the world—a company as mighty, as generous and as democratic as the United States Government itself. Just as Uncle Sam protected them during the war, so he stands ready to continue this protection through the days of readjustment and peace.

The privilege of continuing Government insurance is a valuable right given as part of the compensation for heroic and triumphant services. If the insurance lapses, that right is lost. But if present insurance is kept up—by the regular payment of premiums—it can be changed into a standard Government policy without medical examination; meantime keeping up present insurance at substantially the same low rate. The Government will write ordinary life insurance, 20-payment life, endowment maturing at age of 62, and other usual forms of insurance. This will be Government insurance—at Government rates.

Soldiers and sailors should carry back to civil life, as an aid and an asset, the continued insurance protection of the United States Government by holding on to Uncle Sam's insurance.

COMPRESSED AIR from a compressor should not be used for cleaning relays when blowing out the switchboard. Air may be blown into the relays, making them inoperative. A bellows answers the purpose for cleaning the relays.—ELECTRICAL REVIEW.

Steam Expansion---I*

ACTION OF STEAM IN CYLINDER; CARNOT AND RANKINE CYCLES; ENGINE EFFICIENCY; RATIO OF EXPANSION; SIGNIFICANCE OF CLEARANCE. BY ROGER TAYLOR

IN considering the action of the steam in the cylinder of a steam engine, it must be remembered that the work is obtained from the heat energy contained within the steam, which is simply the vehicle by which the potential energy of the fuel is transmitted to the engine. The various conditions of the steam, as regards pressure and temperature, determine the amount of heat energy a pound of steam delivers to the engine and of this amount supplied a very small amount is actually utilized and transmitted into work by the engine, the balance being rejected in the heat contents of the steam at exhaust, so that it follows that the efficiency of the engine is comparatively low, when considered in connection with the heat supplied.

This results from the fact that, in employing a common medium such as water, as the heat vehicle, the

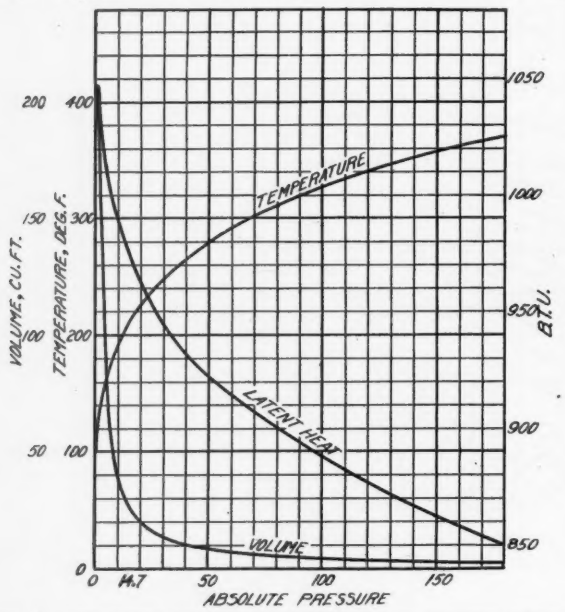


FIG. 1. RELATION BETWEEN PRESSURE AND TEMPERATURE, VOLUME AND LATENT HEAT

water, while in a fluid state, offers great resistance to any change of volume, its elastic tendency is small and the minute particles or molecules are strongly cohesive, therefore it has very little merit as a heat carrier. However, by the addition of sufficient heat and absorption of the heat by the water, a change of state can be made; the water can be converted into a vapor, in which the molecules of the mass are repellant to each other and are capable of performing work, owing to the expansive and elastic tendency, while so repellant. In order to make such a change of state from fluid to vapor, a very large amount of heat is necessary. The heat applied for this purpose is termed latent heat, and is the greater portion of the heat supplied.

Figure 1 shows that although the latent heat necessary to convert the water into steam, decreases as the pressure increases, it still remains a very large part of the total heat necessary at any pressure. At the time of the exhaust of the steam from the engine, its condition will be such that it will contain a very large part of the latent heat, corresponding to the amount necessary for steam generation at the given exhaust pressure. The amount of latent heat so remaining being dependent upon the amount of moisture contents in the steam at exhaust. In any case, this heat rejected is very large. Figure 2 shows this clearly, the curves being plotted to show the amount of heat given up to the condenser after expansion from boiler pressure P to exhaust pressure p. It will be seen that with steam at any given boiler pressure, the lower the final pressure at exhaust is carried the lower is the amount rejected to condenser, therefore

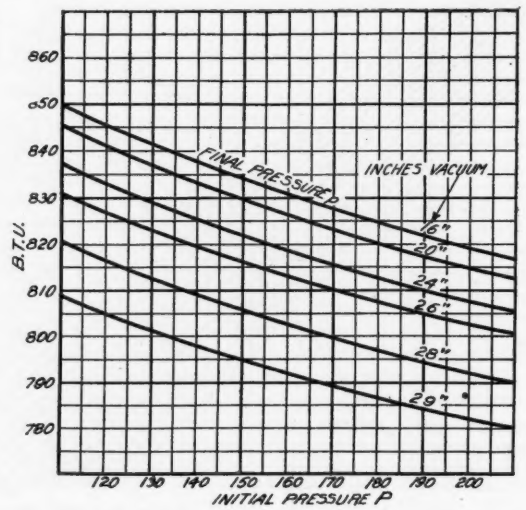


FIG. 2. B.T.U. REJECTED TO CONDENSER ABOVE EXHAUST TEMPERATURE AFTER ADIABATIC EXPANSION FROM PRESSURE P TO p

the greater is the amount utilized by the engine and converted into work. Figure 3 shows these values. It should be clear, then, that the efficiency of the engine must of necessity be quite low thermally. Actually the performance may be very good when compared to that which is theoretically possible in a perfect engine.

ENGINES OF COMPARISON

IN ORDER to have some means of comparing the performance of engines, it is usual to take an ideal engine, working under the same set of conditions, as to initial and final pressures, as the actual engine, to obtain the maximum theoretical efficiency it would be possible to realize under these same conditions. These perfect engines of comparison have not and do not approach very closely to 100 per cent efficiency; for in order to do so, it would be necessary that all heat supplied should be transformed into work, and we have seen that a very

* Part of a lecture course of the Free Engineering School of the United States Shipping Board at which the writer is an instructor.

large amount of the heat must be given up by the exhaust steam, without performing any useful work within the engine. If this heat were not present, the substance could not be in the form of steam. In the ideal engine of comparison, it is assumed that there are no losses from radiation, conduction, friction, condensation, etc., that all available heat that it is possible to convert into work is so converted.

As it is impossible for the actual engine to operate without the foregoing losses being present to some degree, the efficiency of the actual engine must of necessity fall short of the theoretical. The efficiency ratio, as it is termed, is the ratio of the actual efficiency to the theoretical efficiency and it is possible that with certain engines this ratio may be quite high, indicating that the performance of the actual engine may be very satisfactory and that the losses, as far as human agencies can control, have been reduced to a minimum.

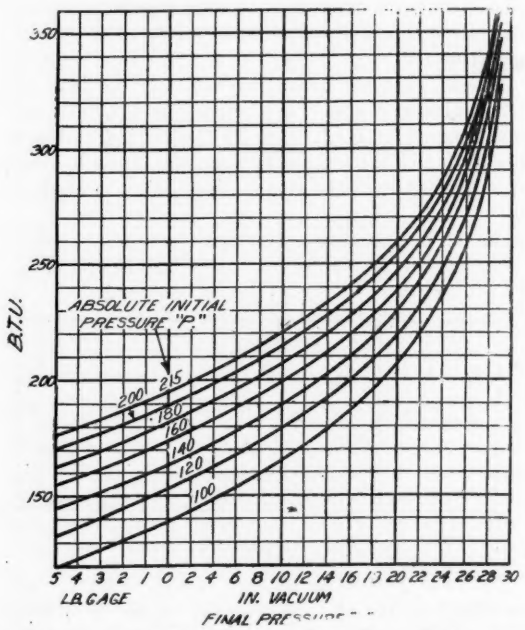


FIG. 3. B.T.U. UTILIZED IN EXPANDING FROM INITIAL PRESSURE P TO FINAL PRESSURE p

The efficiency of a machine is the ratio of the heat energy used to energy supplied expressed as a fraction.

The Carnot Cycle

There are in use two standard steam cycles of comparison: First, the Carnot; second, the Rankine. The former is expressed in a very simple manner, as a fraction $\frac{T-t}{T}$, in which "T" is the absolute temperature of the working substance at the higher temperature limit, and "t" is the absolute temperature at the lower temperature limit. Then the greater the value of the numerator T—t in the above fraction, or the greater the range of temperature the substance passes through during the cycle, the higher will be the maximum efficiency. The temperature range may be increased by increasing the value of the initial temperature, or by a decrease in the final temperature, and it will be seen later that in decreasing the final temperature, by reduction of the back pressure at exhaust, due to an increase in partial vacuum, the increase in the maximum theoretical efficiency is much more pronounced than by an increase in the initial temperature.

It must be remembered, however, that there is a limit to the extent that the final temperature can be decreased, depending upon the size and type of prime mover employed, and as the volume that the steam attains in the lower pressure regions becomes large it has a limiting effect upon the final pressure carried by the reciprocating engine. An example of the above Carnot cycle to an actual engine working between the following pressure and temperature limits follows: 200 lb. absolute pressure expanded down to exhaust pressure of 26 in. vacuum the temperatures are 381.8 and 125.4 deg. F. respectively. Then T equals 381.8 + 460.6 = 842.4 deg. abs. and t equals 125.4 + 460.6 = 586 deg. abs. As the value of the absolute temperature may be left out of

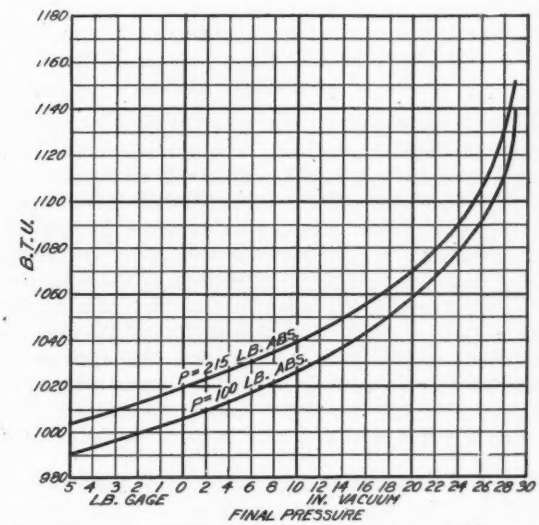


FIG. 4. B.T.U. SUPPLIED BETWEEN PRESSURES P AND p

both terms of the numerator, the fraction becomes $\frac{381.8 - 125.4}{842.4} = 30.4$ per cent as the Carnot efficiency of the engine working between the above pressure limits and represents the maximum efficiency possible but never attained under the pressure conditions.

Reference to Table I will bring out the point of the very material increase of the ideal Carnot efficiency by the reduction of the final pressure. Note that with steam of 100 lb. absolute pressure used in a noncondensing engine, expanding to atmospheric pressure 14.7 lb. absolute, the maximum efficiency possible is 14.6 per cent and further, that by increasing the initial steam pressure to 200 lb. absolute and expanding as before to the atmospheric pressure, 14.7 lb. absolute, the maximum efficiency becomes 20.1 per cent. If, however, instead of increasing the initial pressure, it is maintained at 100 lb. absolute and the final pressure be decreased to that due to 26-in. vacuum, the maximum efficiency becomes 25.6 per cent. In the first place, by an increase in initial pressure of 100 lb., the efficiency has been raised from 14.6 to 20.1 per cent; and in the second, by a change

in the pressure range of only approximately 13 lb. the efficiency was increased from 14.6 to 25.6 per cent. Clearly, from the foregoing, it is desirable to lower the final pressure as low as possible, depending upon limits permitted by the size and type of the particular engine.

While the Carnot cycle is very easy of application, it is not the generally accepted standard engine of comparison used. The substance employed is assumed to pass through four successive stages in the cycle, finally returning at the end of the fourth, back to its initial condition at the beginning of the first, the same working substance having been alternately heated and cooled in the cylinder. During evaporation the steam is at con-

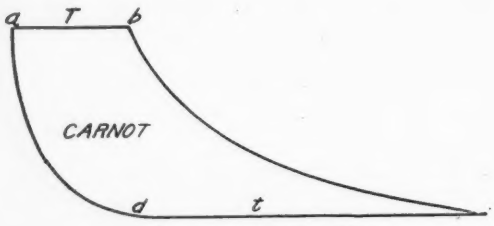


FIG. 5. THE CARNOT CYCLE

stant temperature and all heat received must be received during this isothermal period. This corresponds to stage 1 represented by a b, Fig. 5. After this no further heat is supplied and the substance is expanded adiabatically to back pressure from b to c, work being performed during this period by the internal energy of the steam. During these two periods, work is done by the substance. In the third period, cd, which consists of compression at constant temperature, it is assumed that all heat abstracted from the substance is removed during this operation, by the cooling of the substance within the cylinder. The fourth and last stage is an adiabatic compression of the substance from d to a where the substance

TABLE I. LIMITING EFFICIENCIES OF CARNOT CYCLE

Initial Pressure Absolute	Temperature of Exhaust, Degrees F.									
	218.5	212	175.9	161.4	140.6	133.7	125.3	115	101.1	79
	Absolute pressure at Exhaust, lbs. per sq. in.									
	16.7	14.7	6.84	4.88	2.95	2.44	1.95	1.46	0.97	0.48
	Maximum Efficiency, Per Cent									
100 lb.	13.1	13.9	17.9	19.6	21.8	22.7	23.5	24.6	26.1	28.6
120 "	14.2	15.1	19.1	20.6	22.9	23.7	24.6	25.6	27.2	29.6
140 "	15.4	16.1	20.1	21.6	23.8	24.6	25.4	26.5	28.2	30.4
160 "	16.3	17.0	21.0	22.5	24.7	25.5	26.2	27.3	29.0	31.1
180 "	17.2	17.8	21.8	23.2	25.5	26.1	27.0	28.0	29.5	31.7
200 "	17.9	18.6	22.4	23.8	26.1	26.8	27.6	28.6	29.9	32.2
215 "	18.3	19.1	22.7	24.0	26.3	27.0	27.8	28.8	30.0	32.3
	Vacuum inches Mercury corresponding to Exhaust Pressure									
		0	16	20	24	25	26	27	28	29

has returned to its initial condition at the beginning of the cycle. In stages 3 and 4, work must be done upon the substance and the difference in the amount of work done by the substance during stages 1 and 2 and the amount done upon the substance during 3 and 4 represents the net amount of work done by the substance. Since the work done during stages 2 and 4 adiabatic expansion and compression are equal to each other, the net work done will be that due to the difference in the heat supplied during the isothermal expansion at T, and the heat rejected during the isothermal compression at t, and the efficiency will be the net heat converted into work during these operations divided by the total heat supplied during stage 1 or $\frac{T-1}{T}$.

THE RANKINE CYCLE

INASMUCH as the actual engine has a fresh supply of the working substance at each stroke, it is now usual for purposes of comparison to use an ideal engine similarly supplied. The Rankine cycle is used and as in the Carnot, consists of four stages. The efficiencies obtained in using the Rankine cycle are somewhat lower than those used in the Carnot cycle, as will be seen by reference to Tables I and II, which are the limiting efficiencies of the Carnot and Rankine respectively. In the Rankine cycle the four stages are as follows:

1. Feed water is raised from temperature of exhaust to the temperature of admission d-a, Fig. 6.
2. Evaporation at constant admission temperature a-b.
3. Adiabatic expansion to back pressure b-c.
4. Rejection of heat at constant temperature of exhaust from c-d.

In this cycle, the quantities used are the heat values of the substance and the efficiency is the ratio of the actual number of B.t.u. used by the engine, to the number supplied to the engine between the limits of pressure and temperature of the steam supplied at admission and at exhaust, or stated as a fraction $\frac{\text{heat used}}{\text{heat supplied}}$.

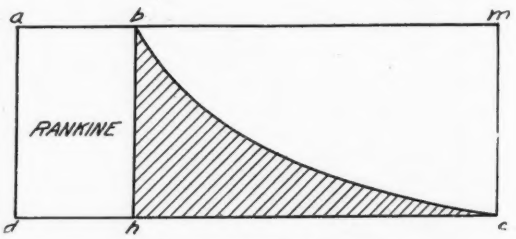


FIG. 6. THE RANKINE CYCLE

The heat utilized is $H - H_1 + (N_1 - n)\,T_1$ and the heat supplied $H - h_1$. All of the values here involved can be obtained from the various later steam tables, with the exception of T, which is the absolute temperature of the steam at exhaust pressure, the steam tables giving the actual temperature as indicated by a thermometer, it is necessary to add to this 460.6, which is assumed to be the point of absolute zero temperature below 0 on the Fahrenheit scale. Assume a case in which steam of 200 lb. absolute pressure is expanded to a pressure at exhaust of 1.95 lb. absolute corresponding to 26 in. vacuum. Then

H = Total heat of 1 lb. steam at pressure supplied above 32 deg. F. = 1198 B.t.u.

H_1 = Total heat of 1 lb. steam at exhaust pressure above 32 deg. F. = 1114.7 B.t.u.

N_1 = Entropy of 1 lb. steam at exhaust pressure = 1.9197.

n = Entropy of 1 lb. steam at pressure supplied = 1.5457.

T_1 = Absolute temperature of steam at exhaust = 125.4 + 460.6 = 586.

h = Heat contents of the liquid at exhaust pressure = 93.28.

$$\text{Efficiency} = \frac{H - H_1 + (N_1 - n)\,T_1}{H - h} = \frac{1198.1 - 1114.7 + (1.9197 - 1.5457)\,586}{1198.1 - 93.28} = 27.3 \text{ per cent}$$

This represents the maximum efficiency of the Rankine cycle for an engine working between the above temperature and pressure limits. In both the Carnot and the Rankine, perfect engines of comparison, it is assumed that there are no losses, from radiation, condensation, leakage, clearance, wiredrawing, etc., as must of necessity be the case in the actual engine to some extent.

Figure 6, which is a card representing the Rankine cycle, shows that the expansion is carried down to point C at back pressure and that there are no roundings of corners. Figure 4 is plotted to show the number of B.t.u. supplied between the pressures of admission and exhaust. Note that with an increase in initial pressure from 100 lb. to 215 lb. absolute, the increase in the number of B.t.u. supplied to the engine at any particular final pressure, p, is quite small, while with a reduction of the final pressure the increased number of B.t.u. supplied by the pressure range is markedly increased. These are the values used in the denominator in the above fraction. On the other hand, Fig. 3 shows that the B.t.u. used in the numerator, or the number utilized, increases to a greater extent than the number that it is necessary to supply by the reduction of the final pressure, particularly in the lowest pressure regions. In other words, the rate of increase of the numerator is much greater than the rate of increase of the denominator, as the pressure range is increased from any given initial pressure, therefore the efficiency will be greater.

Initial Pressure Absolute	Temperature of Exhaust, Degrees F.									
	218.5	212	175.9	161.4	140.6	133.7	125.3	115	101.1	79
	Absolute pressure at Exhaust lbs. per sq. in.									
	16.7	14.7	6.84	4.88	2.93	2.44	1.95	1.46	0.97	0.48
	Maximum Efficiency, Per Cent.									
100 lb.	15.8	14.6	19.2	21.0	23.7	24.6	25.6	26.9	28.7	31.5
120 "	16.2	16.0	20.5	22.4	24.9	25.8	26.9	28.1	29.9	32.6
140 "	16.5	17.2	21.7	23.5	26.0	26.9	27.9	29.2	30.9	33.6
160 "	17.5	18.3	22.7	24.5	27.0	27.8	28.8	30.1	31.8	34.5
180 "	18.5	19.3	23.6	25.3	27.8	28.7	29.7	30.9	32.6	35.2
200 "	19.3	20.1	24.4	26.1	28.6	29.4	30.4	31.6	33.3	36.2
215 "	19.9	20.8	24.9	26.6	29.1	29.9	30.9	32.1	33.7	36.4
	Vacuum inches Mercury corresponding to Exhaust Pressure									
		0	16	20	24	25	26	27	28	29

TABLE II. LIMITING EFFICIENCIES OF RANKINE CYCLE

(To be continued)

Buy Necessities Now

IT IS a public duty to do whatever is consistent with good business to help the demand for manufactured products. While nobody doubts that, as soon as industry gets back to normal conditions, there will be the usual volume of manufacturing and buying, there is a hesitation due to readjustment of conditions that is resulting in the slowing down of shops and factories, and the number of unemployed is increasing. This gives the enemies of society an unfortunate chance for agitation, and Russia is an example of what may result.

It is not a time for a worker out of work to be finicky as to the job that he takes; but unless some kind of work is provided he cannot get any job, and it is only by a demand for materials and manufactured articles that the chance can come. Government work may be started in time; but the process is slow, and most government improvements are waiting for spring weather.

It is not a time for buying luxuries or spending needlessly. Taxes are coming; another Liberty Loan must be financed, and War Savings Stamps are to be bought. But necessities must be had, and buying them *now* will help to keep workers employed during the time of industrial readjustment and waiting for the starting of government projects.

If each one will buy what he needs at once—no more than he needs—it will add a large volume to the demand for products, and will help the situation materially.

One Wire—Many Talkers

SENDING several telegraph messages over a single wire has long been a common practice. But a similar use of telephone wires has now become an accomplished fact and has been done regularly between Baltimore and Pittsburgh for over two months.

By this system, besides the telephone conversation by the usual method, four other conversations can be carried on over a single pair of wires, thus making one line carry five messages simultaneously and without interference.

By combining two telegraph lines into a single metallic circuit it is possible to use this line for five telephone conversations, or for 40 telegraph messages or partly for one and partly for the other.

The apparatus and methods used do not make the system advantageous for short lines, but on long lines its use will be extended as rapidly as apparatus is available and necessary changes in lines can be made.

IN GREAT BRITAIN a commission has been appointed to advise steam users how to avoid waste. This includes 400 experts who are to consult with plant owners and operators to determine where wastes occur and the remedy.

Reports on 364 of the 45,000 plants indicate that the work so far done will result in saving 106,000 T. of coal a year by better combustion, using hot gases to better advantage, teaching firemen, utilizing exhaust steam and discharge from condensers, adjustment of engine valves, better insulation of piping, and cutting out pipe lines not in use.

THE AVERAGE man, regardless of race, likes to be appreciated. Next to that, he likes to have his fellow countrymen appreciated. What is simpler than to recognize in some fitting way the national holidays of the foreign-born! One company says that on Italy-American day all of its officers, down to the last foreman, wore a red carnation in honor of the day, and it "beats an increase in the pay envelope all hollow for promoting a better spirit." Why not the Italian flag alongside the American flag on Columbus Day? Why not an appropriate poster or a message to the French on Bastile Day, and so on down the line? On our own special days we will get in return a full measure of appreciation in a joint celebration of their meaning to us and to the world.

Worcester's Fuel Saving Campaign

FIRST ARTICLE OF A SERIES ON THE ORGANIZATION, WORK OF COMMITTEES AND RESULTS OBTAINED IN INDUSTRIAL PLANTS OF THAT NEW ENGLAND CITY. BY S. E. BALCOME

ALTHOUGH following the general plan of organization as outlined by the New England Fuel Administrator, the Worcester Fuel Committee went a little further and followed the scheme given below:

ORGANIZATION

CITY FUEL COMMITTEE (three members).

Factory Fuel Conservation Committee (three members).

Engineers Sub-committee (eleven members).

Factory Fuel Committees (one to one hundred).

The Worcester Fuel Committee were appointed by the State Fuel Administration and were selected for their ability to organize and carry out the ideas of the Fuel Administration rather than for their knowledge of coal and fuel saving. This committee appointed a committee of three to handle the saving in the industries. It was called the Factory Fuel Conservation Committee and was composed of the general managers of three of the largest fuel consumers of the city and was given complete charge of conserving fuel in the manufacturing plants. Later this authority was extended to stores and office buildings. This committee, made up of J. F. Tinsley, general manager of the Crompton and Knowles Loom Works; G. N. Jeppson, works manager of Norton Co., and F. H. Willard, general manager of the Graton and Knight Manufacturing Co., appointed 11 practical engineers from the largest coal users in the city to act as inspecting engineers. Many of these engineers were technically trained men, but all were actively engaged in fuel work in their own plants. In order to start the fuel conservation work, two meetings of the managers of the Worcester industries were called, one meeting being for concerns making their own power and one for power using concerns. It was specifically stated at these meetings that the committee did not wish to interfere in any way with production, but would rather increase production if possible; it did intend, however, to take measures to save fuel. Cutting down production in order to use less fuel is not saving; but there are many ways in which fuel is wasted, and the sub-committee of inspecting engineers, co-operating with the individual factory committees, were to find out and correct the causes of waste. Pledge cards were signed by the factory managers on which they signified their willingness to support the movement. A copy of these cards is shown below.

PLEDGE CARD

UNITED STATES FUEL ADMINISTRATION FOR MASSACHUSETTS

Realizing it to be our patriotic duty to assist the Fuel Administration in the Conservation of Fuel, we hereby promise to do everything in our power to increase the efficiency of our plant and to appoint a "Factory Fuel Committee" whose duty it will be to detect and correct all inefficient methods of producing and using power, heat and light throughout the plant.

(Signed) .....

Name of plant .....

Address .....

FIG. 1. PLEDGE CARD SIGNED BY MANUFACTURERS AT WORCESTER

This pledge was readily agreed to, in fact the very best co-operation was given by the industries. It was feared at that time that there would not be enough coal to last throughout the winter and it meant that if a certain per cent was not saved in each factory somebody would run short and it was the hope of the committee that this would not happen, but that the supply could be made to last through the winter.

After the way had been prepared by these meetings the engineers were to be sent out to the factories in their district. To each of the 11 engineers a certain district was appointed, giving each man about 25 factories. It was explained that the engineers would meet the factory committees and go over with them the possibilities of saving in their factory, making an inspection at that time. Where it was found that an improvement could be made either in the manner of using steam or in the care and management of the boilers, a report was to be made out in triplicate and one sent to the factory inspected, one to the Factory Fuel Committee and one kept by the inspecting engineer. These reports were to be made on paper of a specified size in order to be uniform, as they were to be kept by the Factory Fuel Committee until the recommendations on them were carried out. It may not be amiss at this point to say that over 75 per cent of these recommendations were adopted and carried out by the factories through their managers and fuel committees.

Address this report to .....

MONTHLY REPORT OF FUEL CONSERVATION

WORCESTER DISTRICT

Av. No. Employes .....

Mail not later than 25th of month.

Company ..... Plant ..... Date .....

Month of		1916	1917	1918	Reduction over 1916	Reduction over 1917
Hours in operation						
% of Normal Capacity Operated based on avg. of 1916 and 1917						
Bit. Coal	Net Tons					
Ant. Coal	Net Tons					
Coke	Net Tons					
Gas	M Cu. Feet					
Fuel Oil	Gallons					
Wood	Cords					
Other Fuels						
Purchased Power	K.W. Hrs.					
Purchased Power	H.P.					

Remarks: .....

Approved: .....

Chairman, Fuel Committee.

FIG. 2. REPORT BLANK FILLED OUT BY FACTORY EMPLOYE

Report blanks, of which a copy is shown herewith, were to be filled out by the chairman of each committee, giving data on the amount of coal or fuel used there, giving also the proportion of business done each year in order to get an idea of saving from month to month.

After all the reports were in for the month, the coal usage of 1918, as compared with 1917 was entered on a chart under the name of the plant from which the report

was received and in a group according to the inspecting engineer's name. This gave the Fuel Committee some idea of the 1918 usage as compared with that of the year before and knowing the amount of coal being received into the city, they could tell in advance what the outlook was to be. Plants that were doing more work than they had done in 1917 were starred opposite that firm's name, so that if the figures showed an increase the plant sending in those figures would not be called to account if their increase in business justified the increase in coal.

As hard coal was especially scarce in some sizes, apartment houses burning hard coal had their coal allotted to them according to the supply in sight. Where a complaint was made that the kind of coal given to them could not be used in their boiler, one of the engineers was sent to investigate the case and report to the chairman of the Factory Fuel Committee.

Bulletins giving general rules for saving heat throughout the shops and also showing the proper care and management of the boilers were distributed among the engineers and firemen. Some of these bulletins were published by the Travelers' Insurance Co., who generously furnished enough to go around. The concerns were also advised to send for Government Publication No. 80, which gave brief rules for proper firing.

Everything possible was done to help the concerns in their efforts to save fuel, and the engineers spent considerable time, at the request of various concerns, in looking up costs and improved methods to aid them. The services of the engineers were furnished by the industries for which they worked and they drew no remuneration. As there were 250 plants to be covered, it can readily be seen that the time spent on this work by each engineer was considerable.

In order that there should be no question as to the authority each engineer would have to go into any plant, the Fuel Administration in Washington furnished each engineer with a card pass having his description and photograph on the back and signed by Director Garfield.

Another form of education was the publication of a monthly Fuel Conservation News Letter which, in addition to methods of saving, published the names of the Factory Fuel Committee Chairmen and items giving what each concern was doing to conserve fuel. This was published under the concern's name. This paper was the most popular thing done by the engineers and if a concern was left out of an issue the editor immediately heard from it with news for the next number. On the signing of the armistice, the publication was held up and the activities of the engineers ceased.

The individual factory committees which were organized by the industries were to be composed of as many members as was necessary to keep watch of their own factories. They were to have periodical meetings to keep up their enthusiasm and as a matter of education, to compare notes, bring up questions and put in recommendations for saving heat and fuel.

Small concerns did not need many members, but large factories required as many as 75 and even 100 members, so as to cover all parts and departments.

Control of Combustible and Air in Burning Powdered Coal*

By W. G. Wilcox

KNOWING the essentials of combustion, we can estimate the value of powdered coal as a fuel. In the same way we can ascertain also the conditions demanded for success in the combustion of pulverized fuel.

The simplest view of the combustion of coal is to regard it as a reaction between fuel and oxygen. It is a heterogeneous system; consequently the velocity of the reaction and its completeness will depend upon the surface exposed by the solid, the pressure of the reacting gas and the intimacy of the mixture. By grinding an inch cube of coal so fine that 85 per cent will pass a 200-mesh screen, we have increased the surface exposure from six square inches to approximately 1800 sq. in. Thus we have increased the velocity of combustion 300-fold. By doing so, we have changed the characteristics of the fuel. We now have a fuel relatively 300 times more active than the inch cube of coal, a new type of fuel that has in it inherent possibilities not to be found in lump or slack fuel. By increasing the surface exposure 300-fold, we have speeded combustion proportionately. This carries with it a further effect. The increase in rapidity of combustion also increases the rapidity of heat evolution, and consequently quickly raises the temperature of the rest of the material. This rise of temperature, which is much more rapid than in the normal combustion of coal, will double the velocity of combustion for each rise of 10 deg. C. The increased rapidity due to greater surface exposure and that due to temperature rise are superimposed so that a pulverized fuel affords a combustion that is hundreds of times faster than when burning lump-coal.

Having a finely-divided fuel, it is possible to form a mixture of fuel and air so intimate that each small particle of coal is surrounded by the proper amount of air. In this condition, by maintaining the proper velocity of the air-current, the fuel can be carried into the furnace in suspension and there burned completely, efficiently and rapidly.

It is, of course, a simple matter to control mechanically the amount of powdered coal delivered to the furnace in a given time. It is also possible to control the amount of air delivered with the coal. If, then, we deliver to the furnace an intimate mixture of air and powdered coal, and control the amount of coal-dust and air delivered, we have the prime essentials. The degree to which they are attained depends entirely upon how carefully we study the characteristics of the fuel before and during combustion.

The amount of coal-dust delivered can be controlled simply and positively by using a screw-feeder operated at variable speed. It is also a simple matter to control the volume of air admitted with the fuel; but the highest efficiency possible with this type of fuel will not be

*From a paper before the Western New York section of the American Chemical Society.

obtained unless we work out a correct way in which to mix a finely divided solid with the air.

A study of the methods for making such a mixture immediately shows that the methods commonly used in making a uniform mixture of two miscible liquids or a uniform solution of a solid in a liquid, or the methods used in mixing finely-ground solids are not only useless in this case, but will actually separate the coal-dust from the air. Ordinary mixing is done by agitation; this agitation is usually accomplished by baffling, stirring, shaking or similar devices. When, however, such methods are applied to a mixture of gas and finely divided solid, the solid tends to separate by reason of its higher specific gravity. This, in fact, is the principle of the well-known cyclone dust-collector. Any mixing device that produces such agitation of the dust and air as to give a centrifugal effect will tend to separate, not mix, the air and the dust.

The importance of mixing the coal-dust and air intimately cannot be exaggerated. The rapidity of combustion is a direct measure of the intimacy of the mixture. This is well illustrated by comparing the ordinary gas-flame with the flame obtained in the Bone combustion system, which consists in forcing the proper proportion of air and gas through a diaphragm having numerous interstices. When this mixture is ignited on the other side of the diaphragm it produces a film of flame.

The poorer the mixing, the longer the flame. The flame simply outlines the area in which combustion is taking place and the length of the flame is a measure of the time element necessary to accomplish combustion. This time element—other conditions being equal—is absolutely a function of the intimacy of mixture, as was noted by Breckenridge ten years ago, when in Bulletin No. 325 of the U. S. Geological Survey, he stated:

"The conclusion is reached that the velocity of combustion decreases enormously from the surface of the fire to the rear of the combustion-chamber, where it is relatively very small, the practical application is that little is to be gained by adding further length of smooth combustion-chamber, which would be commercially as poor an investment of capital, as to add to the length of a Corliss engine-cylinder and stroke; we must resort to thorough mixing."

Just as in the past there has been a remarkable failure to realize the necessity for intimately mixing air and coal-dust, so there has been insufficient consideration of the characteristics of this fuel when burning. Powdered coal has the characteristics of a rich fuel of somewhat higher kindling temperature than producer-gas, natural gas or fuel-oil. To illustrate the fact that it is a rich fuel, we can compare the available B.t.u. in a cubic foot of a correctly proportioned mixture of powdered coal and air and the available B.t.u. in a cubic foot of correctly proportioned mixture of pure methane and air. Take a Pittsburgh coal (heating value 14,157 B.t.u.) of the following analysis:

	Per Cent.
Volatile	35.4
Fixed carbon	58.5
Ash	6.1

We find that a cubic foot of a correctly proportioned mixture of coal-dust and air has available 107 B.t.u., while a mixture of pure methane and the proper amount of air has available per cubic foot, 62.3 B.t.u.

The rapidity of combustion and the completeness of combustion of a mixture of coal-dust and air depend upon a number of factors: for example, they are dependent upon the velocity and pressure at which it is passed into the combustion-chamber. If the velocity of the incoming stream of powdered coal and air is above the velocity of flame propagation, combustion will not take place until the mixture has slowed down to a point that it does not exceed the velocity of flame propagation. When a powdered coal is fired at high pressure and high velocity, combustion frequently does not begin until a point four to six feet from the mouth of the burner. A similar example is found in the plumber's blow-torch when too much air is used, or in the Bunsen burner when the gas-pressure is too high. High-pressure firing not only slows down combustion, thus increasing the size of the chamber necessary, but has a destructive action on the furnace. It has been well established that high velocities in the combustion-chamber or a blow-torch effect due to firing at high pressure (whether oil or gas be used as a fuel) are always destructive of the brickwork. This action is increased in high-pressure firing of powdered coal, since, in addition to the erosional effect of gases at high temperature traveling at high velocity, there is a fluxing action by the melted ash. Furthermore, the slagged ash will be carried along mechanically, leading to further furnace troubles. In one case this resulted in a deposit of slag on the mud-drum of a vertical waste-heat boiler at the end of a long reverberatory furnace. Slowing the velocity not only hastens combustion, but makes it possible to eliminate much of this slag. When the velocity is low the coalesced particles of slagged ash are either larger than will be carried by the velocity of the gas or this condition is so nearly approached that a slight change in direction of the flame will result in dropping out the slag. Thus, in addition to being correct combustion and necessary in order to avoid excessive furnace-maintenance costs, low-velocity combustion, by a slight change in flame direction, permits the dropping out of a large quantity of the slagged ash in the early part of combustion, where it can be removed.

The velocity of combustion is not only dependent upon the fineness of the particles of coal, the intimacy of the mixture and the velocity of the stream of combustible and air, but is affected by the temperature of the combustion-chamber. The kindling temperature of a mixture of powdered coal and air is higher than that of either oil or gas; consequently for successful and complete combustion, it is necessary that the combustion-chamber be maintained above a certain minimum temperature and that the combustion be practically completed before the products of combustion pass over the heat-absorbing surface. Just as you can extinguish a gas flame by passing over it a piece of wire-gauze, so the effect of a chilling surface will be even more marked with this combustible material than with burning gas, since the particle of coal is infinitely larger than a molecule of gas and the kindling temperature is also higher. This has a direct application to the successful firing of locomotive boilers, water-tube boilers and return-tubular boilers. If the combustion of powdered coal be not

sufficiently developed before the flame enters the tubes of the locomotive boiler, combustion will be checked and coked coal will settle out in the tubes. If, on the other hand, combustion be sufficiently developed before the flame is brought in contact with the heat-absorbing surface, complete combustion and high efficiency are obtained.

A study of the flame developed at a low pressure by an intimate mixture of coal-dust and air shows that combustion is extremely rapid. In a copper-reverberatory furnace at Florence, Colo., where this type of combustion is used, coal burned at the rate of approximately one ton an hour develops a flame that vanishes within six feet of the burner, combustion being complete at that point. Let us translate this into terms of natural gas, in which case the fuel consumption would be approximately 26,000 cu. ft. per hour or 433 cu. ft. per minute. You can picture to yourself this quantity of gas being burned at low pressure and developing a flame only six feet long. Samples of gas taken in the flame show a content of CO_2 as high as 16 per cent only 5 ft. from the mouth of the burner. This will give an example of the rapidity with which combustion can be obtained and the possibilities of shortening the flame. With proper equipment it is equally practicable to lengthen the flame until it will spindle out a distance as great as 100 or 120 ft. However, with an intimate mixture under control, this must be done by supplying insufficient air. Under such conditions combustion is incomplete and the flame spindles out because combustion continues to develop throughout the length of the furnace as air-leakage supplies additional oxygen. This is proof of the statement that the length of flame is an actual measure of efficiency of mixing and the adjustment of the fuel-air ratio.

Thus, it is seen that we have changed entirely the characteristics of coal as commonly known. Powdered coal is a fuel of extreme flexibility, in that the amount burned can be varied within wide limits. It is a fuel that develops a flame whose length can be adjusted. The character of the flame can be altered to suit the metallurgical operation. In short, the basic fuel, coal, has acquired the characteristics of oil or gas, but with better and closer control. Furthermore, the possibilities of this fuel are not only capable of realization, but are actually being utilized in commercial practice today. To the flame characteristics of a rich fuel, developing a flame like oil or gas, is added a degree of control not yet obtainable in burning either oil or gas. This statement is made advisedly. The possibilities of such combustion for the improvement of processes, for fuel economy, for increasing output, through its ease of control and elimination of heavy labor, are realized by few. Owing to the attitude of labor and the scarcity of skilled operatives, it is far more difficult than ever before to secure high efficiency and good operation in hand-firing, stoker-firing or in producers, in short, whenever such efficiency depends upon constant watchfulness and hot, heavy, disagreeable work. For these conditions powdered coal substitutes an ease of control such that the equipment can be handled by an old man or a boy, while it is so simple that a man of ordinary intelligence can soon be taught all that is necessary for good efficiency operation. The possibilities of such control in the place of present-day combustion methods, which permit high efficiency only by the most strenuous effort, through substituting for these a type of combustion whereby high efficiency is easily obtained, are certainly of great importance to us at the present time.

Some War Activities

WE are beginning to get an idea of the scale on which our war activities were really working. Gen. G. E. Tripp, of the ordnance department, who has now returned to his duties in New York as Chairman of the Board of the Westinghouse Elec. & Mfg. Co., gave some interesting facts in a recent interview.

Not only did the company and its employes bear a full share in furnishing men and officers to the army, in buying bonds and contributing to Red Cross funds, but 500 cars of shells a day were shipped from its plants in the Pittsburgh district; of the 4.5-in. shells, the output was 24,000 a week, and of the 8-in., 5000 a week. Total output has been 6,000,000 shells, a half million rifle grenades, and a half million grenade dischargers.

The New England Westinghouse Co. turned out a million rifles in a year, and during the last week averaged 7000 a day. Also of the Browning machine gun 3000 a month were made. At Esington, near Philadelphia, a new plant was built which made complete marine propulsion equipments, over 350 being finished or under way when the armistice was signed.

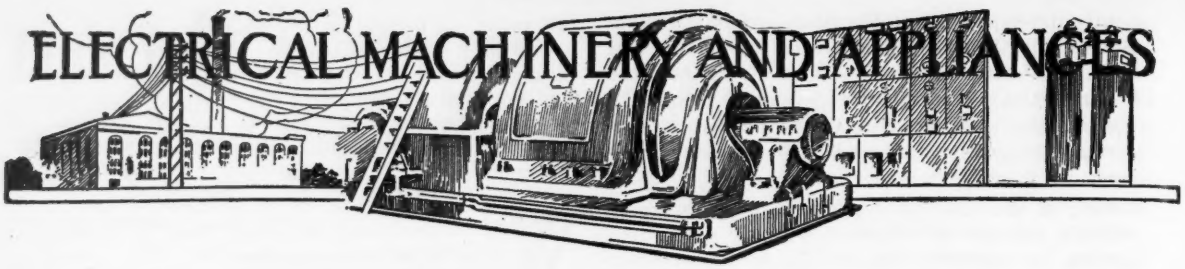
These figures give some idea of what one organization with its plants and its 40,000 workmen was able to do in helping to win the war, and form a basis on which to get an idea of what our war program really meant.

NOT THE actual strength of the American army in France, though that could perhaps have forced surrender of large numbers of German troops, but the preparations under way which insured overwhelming defeat of Germany in 1919 was the cause of the sudden ending of the war. If the Germans had not known of the great stream of shells, gas, tanks and other munitions that was ready to flow forward they might have fought on through 1919, and the battles would have cost the lives of 200,000 American soldiers.

But we were making more mustard gas than Great Britain, France and Germany combined. Our tank program called for one tank for every 75 ft. of front; artillery and shells were under way that would have blown the German army off the face of the earth. And they knew it.

So that, although we are paying for a great mass of material that never reached the front, it is really a payment for the saving of 200,000 lives of our boys, and wounds that cannot even be estimated.

Expenditures during December were $2,060,000,000, in paying the expenses of the army still in the field, transportation home, demobilization and settlement of contracts for war material. It is for such expenses that the Fifth Victory Liberty Loan must be raised. It is a thank offering for the lives and limbs of our boys who need not be sacrificed because we went at our job in such a big way. We can well afford to see it through financially. And our bill is much less than it would have been had the war gone on for another year.



Characteristics of Electric Motors---III

Single-Phase Motors

SINGLE-PHASE alternating-current motors may be of the induction, the repulsion, the repulsion starting and induction running or the series type. The straight single-phase induction motor, unless provided with a phase-splitting device or a shading coil, develops no starting torque when its rotor is not revolving, and as a consequence occupies but an exceedingly limited field. With the use of a phase-splitting device or a shading coil this disadvantage is, however, eliminated.

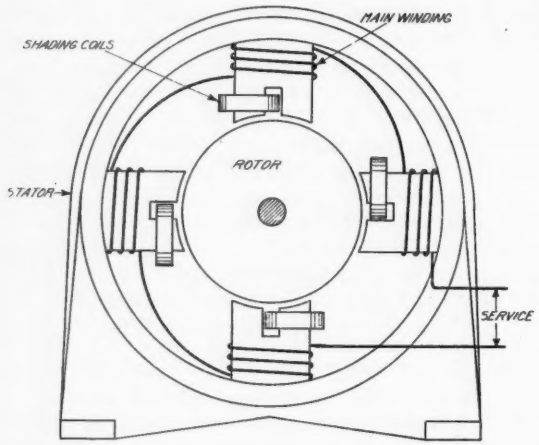


FIG. 13. METHOD OF USING SHADING COILS FOR STARTING SINGLE-PHASE MOTORS

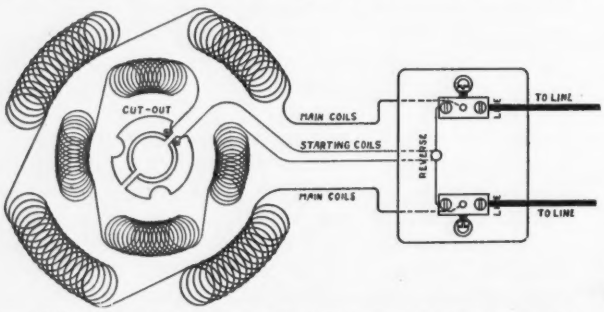


FIG. 12. SINGLE-PHASE MOTOR ARRANGED FOR SPLIT-PHASE STARTING

Where split-phase starting is employed the motor is fitted with two distinct windings, displaced as shown in Fig. 12, 90 deg., and known as the starting winding and the running winding. The starting winding circuit is so arranged as to possess considerably more inductance, capacity or resistance than the running winding, with the result that a rotating magnetic field is created and the rotor enabled to start. After the rotor has reached synchronous speed, the starting winding is cut out of circuit and operation generally accomplished automatically by means of a centrifugal switch embodied within the revolving member.

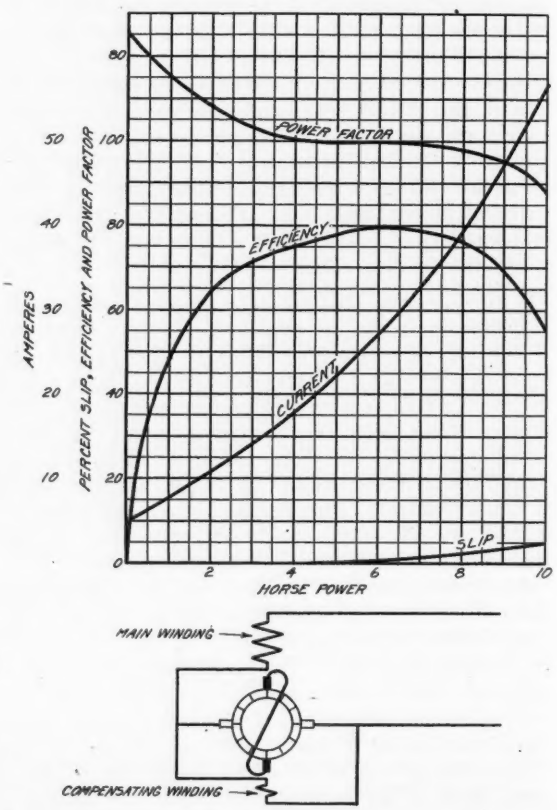


FIG. 14. ELEMENTARY DIAGRAM OF CONNECTIONS AND CHARACTERISTICS OF A UNITY POWER-FACTOR MOTOR

Motors designed for starting on the shading coil principle have their pole pieces fitted with short-circuited bar windings in the manner indicated in Fig. 13. The flux created by the flow of alternating current through the main winding passes through the pole pieces

and induces in the shading coils a secondary current, the resulting magnetic field of which tends to oppose that portion of the pole flux producing it. Due to the fact that therefore the flux in the unshaded portion of the pole pieces renders its maximum value at a different instant from that emanating from the shaded portion, and the displacement of the two halves of the pole pieces, a revolving magnetic field is established, thus enabling the motor to pick up speed.

This scheme, like that of the split-phase arrangement, is applied only to motors of fractional horsepower capacity.

Due to their very nature, and as their name implies, induction motors, tend to draw a lagging line current. As a result, and especially where many small and underloaded induction motors are installed, extremely low lagging power factors will be encountered. To eliminate this trouble and not only improve the lagging power factor, but also to provide a machine drawing a leading line current, the Wagner Electric Co. has

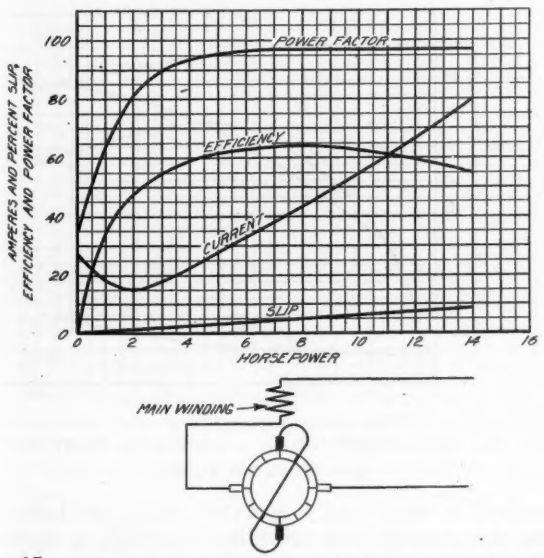


FIG. 15. DIAGRAM OF CONNECTIONS AND CHARACTERISTICS OF UNITY POWER FACTOR MOTOR WITH COMPENSATING WINDINGS DISCONNECTED

placed on the market a so-called unity power factor motor. This machine, which is self-starting without clutches or other auxiliary devices, is said to possess approximately unity power factor at full load, with leading power factors at loads from zero to 100 per cent of rating.

An elementary diagram of connections of this type of motor is shown in Fig. 14. Two windings, a main and a compensating winding are employed, the former used to produce the main field flux, while the compensating winding is utilized exclusively for the control of the power factor.

The main winding is of the usual squirrel-cage construction and occupies the bottom of the slots, while the auxiliary winding occupies the space above, a magnetic separator made of soft rolled steel bar being placed between the two. The auxiliary winding is connected to a standard form of horizontal commutator, which in turn is provided with two sets of brushes. One of these, the main pair, is placed in the axis of the main stator winding and is interconnected, giving repulsion motor characteristics; the auxiliary pair of brushes is placed at right angles to the axis of the main stator winding and is connected in series with it. The auxiliary stator winding is arranged to be automatically

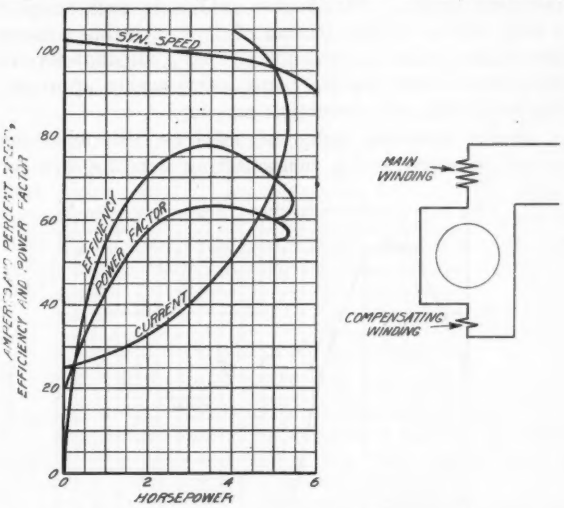


FIG. 16. DIAGRAM OF CONNECTIONS AND CHARACTERISTICS OF UNITY POWER FACTOR MOTOR WHEN ALL BRUSHES ARE REMOVED

connected in parallel with the auxiliary brushes at a predetermined speed, and while this connection improves the power factor and the speed characteristics, it is not essential to the operation of the motor. Should the automatic switch fail to close, the machine would still operate satisfactorily but with reduced power factor and efficiency. The result of this action is shown in

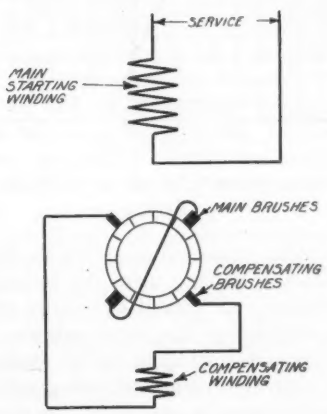


FIG. 17. DIAGRAM OF CONNECTIONS OF A REPULSION-INDUCTION MOTOR

Fig. 15. The machine will operate and carry full load if, after the motor has reached rated speed, all the brushes were removed. It would then operate as a squirrel cage induction motor with characteristics as in Fig. 16.

Motors of this type are particularly well adapted for service requiring power factor correction, and on

account of their inherent torque and speed characteristics are many times preferable to the synchronous motor.

An alternating current motor which, like the series-wound direct-current motor, possesses high starting torque with small starting current and a rapidly decreasing torque with increasing speed, is the straight induction motor. This motor, which is well adapted to such service as the driving of fans, printing presses, blowers and other machines requiring a constant torque, has power factor characteristics more nearly approaching unity than the induction motor.

In the repulsion induction machine, two windings, a main winding and a compensating winding, are em-

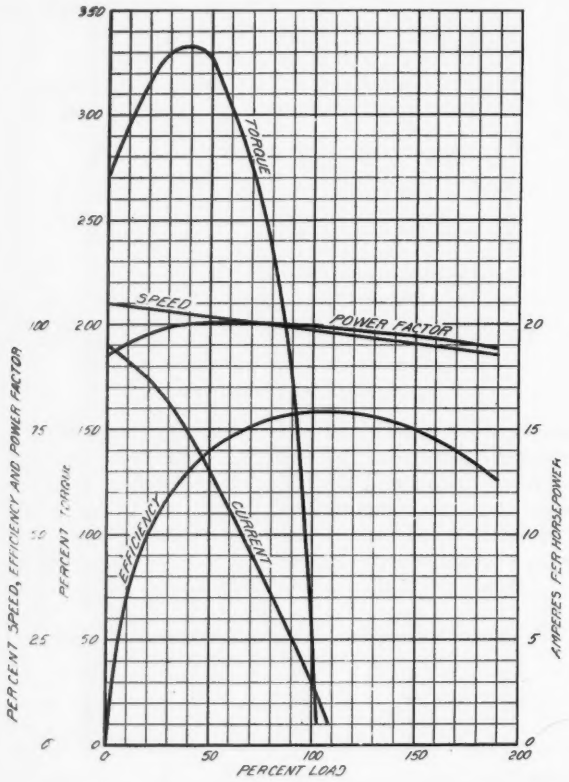


FIG. 18. CHARACTERISTICS OF A REPULSION-INDUCTION MOTOR

ployed, the latter connected as shown in Fig. 17 to compensating brushes bearing upon the commutator in the manner indicated. A second or energy set of brushes having approximately the same angular position in relation to the stator winding as the energy brushes of the straight repulsion motor are also employed.

Efficiency, power factor and speed-torque curves shown herewith graphically illustrate the operating characteristic of a typical repulsion induction machine. The starting torque of a motor of 5 hp. rated capacity and less is 250 per cent of full load torque at all frequencies and of machines of 7½ hp. and more 200 per cent of full load torque. The maximum running torque is about 300 per cent of the starting torque, and as a consequence the motor will accelerate any load it will start.

Power factor values, as may be seen, tend to approach unity throughout the rated capacity of the machine with, however, a slight drooping of the curve at extremely light and full loads.

The efficiency gradually increases with load with the curve between 75 and 125 per cent load quite flat.

Ordinarily the motor is practically a constant speed machine, although variable speed is obtainable by the insertion of a rheostat in series with the energy brushes or by an auto transformer connected in the supply line to vary the applied voltage.

A further modification of the repulsion-induction motor is the repulsion-starting, induction-running machine, which has a single winding isolated from an armature similar in form and construction to the type used in direct current motors. Brushes are provided and electrically interconnected by a metal supporting arm, the number employed being the same as in a given direct-current motor with a like number of pole pieces. Reaction of the stator currents upon the rotor winding induces rotation, and as soon as synchronous speed is

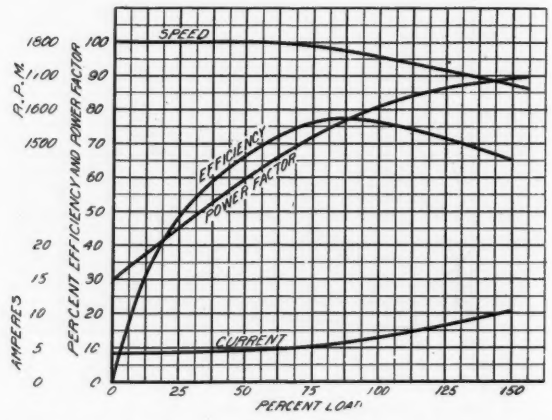


FIG. 19. CHARACTERISTICS OF A REPULSION START INDUCTION RUNNING MOTOR

reached a centrifugally operated device short-circuits the commutator, thus providing essentially a machine of the squirrel-cage type.

The speed of this machine is practically constant, although the power factor is not nearly as satisfactory as that of the repulsion-induction motor. As shown in Fig. 19, its efficiency curve rises quite gradually from zero to about 80 per cent load, after which it declines in the manner indicated.

Motors of this type are well adapted to service similar to that for which the direct-current shunt-wound machine may be employed, and has the advantage of this machine in a considerably greater starting torque. It is not well suited for adjustable speed work.

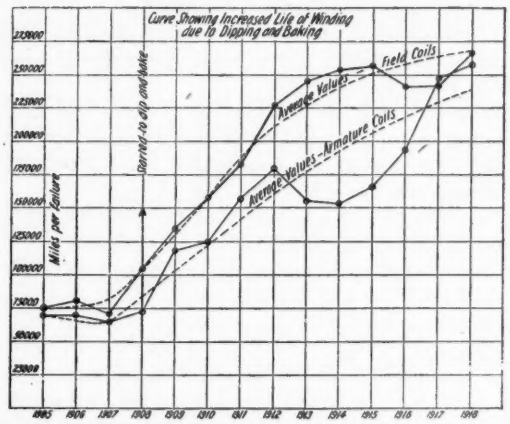
Except for a laminated field structure, series-wound alternating-current motors are practically the same in construction as direct-current machines of the same type, and possess similar characteristics. They are primarily intended for light work, such as the driving of fans, blowers, drills, etc., although due to their powerful starting torque and adaptation of speed to load they are utilized in traction and similar work to a limited extent.

Dipping and Baking as a Financial Asset

By J. S. Dean*

A VERY striking example of what can be accomplished in the way of prolonging the life of railway motor windings by dipping and baking is shown by the following curves with armature and field failures per car miles, plotted against each year's record over a period of 13 successive years.

Referring to these curves, it will be noted that during the year 1908 there was a decided upward trend of both curves, which is due to the fact that at this time the master mechanic in charge of this property instituted a regular and systematic schedule of dipping and baking the windings of his motors as follows: Every 1½ to 2 yr. (approximately 60,000 to 75,000 mi.) during the general overhauling period the field coils and armatures are given a dipping and baking. Should motors be in the shop for other repairs, and if windings appear dry, although they have not made their allotted mileage, they are given an extra treatment at this time.



INCREASE IN LIFE OF WINDING DUE TO DIPPING AND BAKING

Dipping and baking the motor windings on this property has produced the following beneficial results:

Fewer crippled cars.

Less repair work.

More reliable service.

Favorable public opinion.

In addition to the above, it is interesting and instructive to review the financial benefits to be gained, as shown by the following figures:

Referring to the curves, we note that approximately

1. 265,000 mi. (7 yr.'s service) per failure when dipped and baked.

2. 75,000 mi. (2 yr.'s service) per failure when not dipped and baked.

3. 3½ failures (no treatment) to 1 failure (treated) in 7 yr.

4. Which is 2½ failures saved by dipping and baking in 7 yr.

5. On 300 motors this is equal to 300 × 2½ or 700 failures in 7 yr.

6. Which is the equivalent of 100 failures in 1 yr.

7. Assuming that 35 per cent are completely rewound and 65 per cent repaired.

8. Assuming $60 for complete rewinding and $10 for repairs.

9. Then we have (35 × $60 equals $2100; 65 × $10 equals $650) $2750 saved per year.

Approximate cost to dip and bake is $2 per motor, and as each motor is treated every 1½ yr., then we have 300 × $2 × ⅔ equals $400, cost a year; saving $2350 per year; estimated cost to install plant, $1200; which shows a net saving of $1150 the first year, and a saving each succeeding year of $2350.

One of the surprising things about the excellent showing is this property operates old obsolete motors. If it is possible to produce such gratifying results by systematic dipping and baking of these old type motors, nobody should hesitate in urging the adoption of dipping and baking for all types of railway motors. The importance and value of this can be further driven home by pointing out on these curves the remarkable showing made by these motors during the severe winter of 1917-18.

* Railway Engineer, Westinghouse Electric & Mfg. Co.

A New Farm Profession

LABOR is the great problem on the farm at the present time. War conditions and abnormal wages in the various lines of industry have demoralized farm help to such an extent that it is exceedingly difficult to get assistance requisite to carry on operations.

In this state of chaos the Federal Board for Vocational Education has hit upon what seems to be a solution, and has created a brand new profession—that of "farm mechanic," and it is figured that any farm of more than 100 cultivated acres can very well afford to have a man of this sort.

The men being qualified for this work are disabled soldiers, who, before injury were farm boys. With this background of agricultural knowledge these men are being taught to operate modern tractors which do the work of many teams and men. They are being taught operation, care and up-keep of motor trucks and other gas engines. They are being given a general course in looking after all machinery used on modern farms, and indications are that the supply of these specially trained men will not begin to equal the demand. Farm hands who, before the war, could not hope to make more than $25 or $30 a month as laborers can, by becoming proficient as farm mechanics, qualify for positions paying from $100 to $125 a month with steady employment the year around.

It is an exceedingly interesting development of our national rural life brought about by forces of necessity, and is but another illustration of the fact that the emergency is usually met in one form or another.

Farm boys who have been discharged and are disabled as a result of their services either by sickness, accident, or disease would do well to write to the Federal Board for Vocational Education, Washington, D. C., and obtain the particulars of this training which the government provides free for its disabled men.

THE MAN who goes forward to his day's work simply because it is "his job" and he must have the herewith from it to pay for his grub and shoe leather, will never climb very high. Any man who hopes to succeed must be in his job heart and soul. It must be to him the thing he enjoys doing most on earth.—WAYNE WINNERS.

Oxy-Acetylene Welding--II

HINTS FOR BEGINNERS AND POINTERS ON POWER PLANT REPAIR JOBS

ALL plates 3/16 in. thick or over, require beveling in order that the metal on the under side of the weld may be fused so as to unite with the adding material and so secure a perfect union.

As a rule it is best to bevel from one side only. If the plates are thick, this will require more adding material but the ability to complete the job, without changing sides and losing heat, requires less time and less gas, as a rule. Circumstances, however, may make it best to work from each side in some cases.

A joint thicker than ⅛ in., unless prepared by

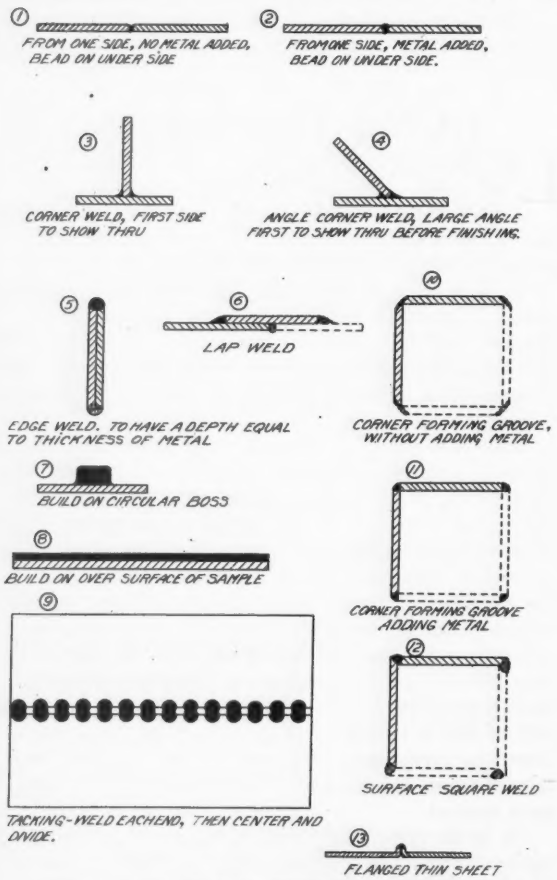


FIG. 1. EXAMPLE OF SHEET STEEL WELDING

beveling, is very liable to be bridged by molten metal, thus preventing the fusion from extending all the way through, with the result that the plate will have a weak spot and any strains of bending or tension will be localized at this point and the work be unsatisfactory.

CAST IRON

CAST IRON contains slag. The mold, being cold, chills the iron and some of this slag is caught by the iron before it can rise to the surface.

Cast iron has a great affinity for oxygen, forming oxide of iron, which melts at a higher heat than cast iron. In fusing cast iron when welding, oxide will coat the molten globules and prevent them running together.

A proper flux dissolves or breaks up the oxide and allows the metal to run together and form a sound weld.

It is necessary that flux materials be of standard purity and thoroughly mixed. The cost of this flux, as prepared by the manufacturer, is so low as to make it very doubtful whether any one can afford to prepare it for his own use.

In welding cast iron we have to deal with slag, dirt, scum, and blowholes. In welding, form a pool at the bottom of the V. Add flux by dipping the hot rod of adding material in the flux powder.

Build up the weld by manipulating the flame and rod. Rub the rod around on the sides of the puddle to break up the oxide. Add flux as necessary, but use as little as possible. Avoid keeping the metal in a melted condition longer than necessary.

Excessive amount of flux, or heating for long periods, produces hard welds. Long heating changes the molten iron to white iron.

The pool should be as large as possible and the surrounding metal kept hot so as to give time for cooling slowly. The slower the cooling the more free graphite is formed, and the softer the iron.

Particles of dirt or oxide that give trouble are often found in cast iron. They adhere to the sides or bottom of the pool and can best be worked out by the rod. If touched with the rod, having some flux on it, the oxide will break or float, join the scum and the slag, and may be skimmed off with the rod. A particle of dirt will often cause a depression in the pool of molten metal. The metal may be closed over the particle by producing a whirlpool of molten metal around the particle by torch manipulation, then withdraw the torch and allow the metal to close over, but it is better to work the dirt out with the rod if possible.

If the joint is not thoroughly fused and filled with adding material, the strength will be lacking. It may be necessary to turn the part over and weld from the other side, when it is seen that thorough penetration and fusion have not been secured.

If the joint is not filled on the reverse side, it results in dangerous weakness. Any sudden reduction in area localizes the strain and may start a fracture.

Bosses can be built up and missing iron supplied by iron from the adding material, which can be done by torch manipulation; but it is generally better to cut carbon blocks to the shape of the part to be added, as it saves time and gas.

Heavier bars require more heat and larger tips.

The heat of the torch is of limited extent. To prevent dissipation of heat and secure thorough fusion it is therefore best to heat to a good red for a distance at least twice the thickness of the plate each side of the weld before trying to fuse the metal for welding.

WROUGHT IRON AND STEEL

STEEL and wrought iron have characteristics that

make them particularly useful in places where subject to flexure or shock. The distinguishing difference between wrought iron, steel, and cast iron is in the carbon content and the different methods of manufacture.

Wrought iron is iron with practically no carbon.

Steel is an intermediate product between wrought iron and cast iron. Mild steel contains from a trace up to 0.5 per cent of carbon, structural material and bar stock having usually less than 0.3 per cent. The carbon content is spoken of by saying the steel is 20 point or 70 point, meaning 0.20 or 0.70 of 1 per cent.

Tool steel contains from 60 to 150 points carbon.

There is a place between 1.5 and 2 per cent where the iron is of little use. Above 2 per cent we have white cast iron, and as the carbon is increased the white iron blends into gray cast iron. Gray iron may run as high as 4 per cent or more total carbon.

Copper

Copper may be welded, but it is difficult. It oxidizes readily and the oxide dissolves in the copper. The flame must be exactly correct, as either oxidizing or reducing flames will have an injurious effect upon the copper.

The heat conductivity of copper is high, heat being carried off so rapidly as to require a larger tip than for steel or iron of the same size.

The parts should be beveled as practiced with other metals, though plates less than ⅛ in. thick may be butt-welded without beveling.

Preheating is often necessary, even on comparatively thin material, on account of the heat being conducted away so rapidly by the metal that it is difficult to fuse the copper.

The adding material should be electrolytic copper containing about 1 per cent phosphorus, which tends to eliminate blowholes. Flux is used only to cleanse the weld and to protect the metal from the gases of the flame.

Copper when melted absorbs gases, which on cooling are given out, making the weld porous. For this reason, keep the white cone of the torch out of contact with the copper. Copper melts at about 1930 deg. F.

Copper is "hot short" at a little above red heat, hence care must be taken that strains of contraction shall not break the copper at the red heat.

A weld in copper is, in effect, cast copper and comparatively weak, but hammering at a dull-red heat improves the strength and ductility.

To weld copper and steel together is comparatively easy, as there is a strong affinity between the two. Due to the high conductivity of copper, care must be taken to secure fusion of both the steel and the copper. Steel requires the higher heat, but the heat should be blended into the copper.

Brass and Bronze

Brass is an alloy of copper and zinc, while bronze is an alloy of copper and tin. In welding either of these the danger is that the zinc or tin will pass off in fumes and the composition be changed.

Manganese bronze or Tobin bronze is very satisfactory as adding material, and should be added just before the surface of the parts begins to bubble. This is true for both bronze and brass.

Brazing is of the nature of soldering, that is, uniting metal parts without fusion, by the use of a metal of lower melting point. Brazing is used to unite steel, iron, copper, bronze and brass. For brazing copper, bronze, and brass, use care in selecting a brazing metal with a lower melting point than the metals to be joined, such adding material being sometimes called spelter.

Prepare the work by cleaning all dirt or scale from the vicinity of the joint. Heat the parts slightly and apply a little good flux, then continue to heat to a full red, or a little above the melting point of the adding material. Apply a little more flux and melt the adding material into the joint, which should fit closely, so that the brazing metal will be drawn in by capillary action. The metal should completely fill the joint.

In all work that requires the melting of brass or bronze, the fumes are very troublesome. If breathed,

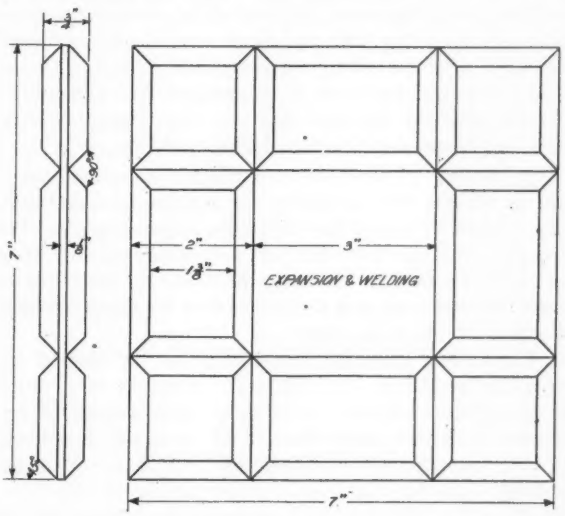


FIG. 2. CAST IRON EXPANSION AND WELDING FOR SEVERAL BREAKS

they will cause disagreeable results that are known to all brassworkers as brass founders' ague, brass chills, zinc shakes, etc.

Aluminum

Aluminum melts at about 1200 deg. F.; it oxidizes easily at 300 deg. or more and the oxide melts at a much higher heat than the metal, which makes it difficult to weld. The oxide prevents the metal joining, the molten metal forming inside a skin of oxide like the yolk of an egg within its skin.

Flux is used to break up or dissolve this oxide, which may be done by puddling in the case of cast aluminum. A little flux is often a help; with sheet metal it is a necessity; but use as little as possible.

An iron rod, usually flattened at one end, is used to puddle the molten cast metal, though some welders puddle almost entirely with the stick of adding material. If the iron rod is allowed to get hot the aluminum will stick to it.

The correct flame should always be used in welding aluminum. Some welders recommend the carbonizing

flame, but those who have studied the matter do not agree with this. The carbonizing flame is not as bad as the oxidizing, which is very injurious, but the "correct" flame is much better than either.

The difficulties in welding aluminum are: Oxide of aluminum melts at a much higher heat than the metal, preventing ready union. Expansion for a given rise of temperature is nearly twice as much as with iron or steel and sets up excessive strains. Aluminum has a very high conductivity, which increases the expansion. When hot, aluminum is very weak, and cannot withstand the excessive strains of contraction.

All the above conditions combine to make aluminum one of the most difficult metals to weld.

Cast aluminum over one-fourth inch thick should be beveled at about 45 deg. on each side. A little good flux will often help in puddling, and is added by dipping the hot rod of adding material or the paddle in the flux and working it into the weld.

Heat with the torch till the metal barely fuses, as shown by scraping with paddle or rod of adding material until a bright spot is produced; then melt off some adding material and work it into contact with the melted casting with the paddle. Dig out any black spots or very bright spots with the puddling paddle.

A backing of fire clay to support the added material is often a help in filling large holes in aluminum. Lay a piece of paper over the hole before applying the fire clay, to keep the edges of the casting clean. It is often convenient to hold the fire clay in place by a piece of band iron, and if the fire clay contains asbestos, it will hold its shape better.

Bosses and missing projections can be shaped up with the puddling stick while the metal is soft, much as the plumber builds up a joint with wiping solder. Carbon blocks are often used to advantage in this work, to save time and gas, and their use is no discredit to the welder's ability. He should make full use of them.

Aluminum is rarely pure but alloyed with zinc or copper. The zinc alloy is very brittle, and does not stand contraction strains as well as the copper alloy. It is duller in color than the copper.

Aluminum with a large zinc content was used in former years, electrolysis between the zinc and aluminum causing deterioration, so that contraction strains in this weakened metal were troublesome.

The size of tip used varies with the skill of the operator, but it is well to start with the size of tip suitable for steel. High conductivity and low melting point about balance each other.

The careful handling of the puddling rod may often be done better with the right hand while the torch is in the left. Work rapidly because of the rapid conduction of heat and the rapid oxidation.

Preheating is often necessary for a beginner, though a skilled operator can usually succeed without preheating, when dealing with the copper alloy. Preheating with a torch is expensive and often produces cracks because of excessive local expansion. A charcoal fire is good.

Care must be used not to overheat any part. Never preheat aluminum above the point which will char a pine stick, or sawdust. Breaks that have been soldered must have all the solder and adjacent metal removed before attempting to weld.

Castings distorted by heat may often be straightened by skillful peening.

Welding sheet aluminum is a delicate operation, particularly on thin sheet and requires considerable practice. On thin stock turn up a small flange, not over 1/16 in. to supply the welding material. Clean thoroughly by scraping.

Dilute the flux with water and paint it on the parts with a brush, as too much flux interferes with the welding. Dry with the outer point of the flame.

Aluminum flux is expensive and deteriorates by contact with the air, hence keep the can closed tightly when not in use.

The torch must be moved rapidly along the joint, requiring much skill to weld thin sheet.

After welding wash off all flux left on the surface with hot water, to remove danger of electrolysis. The seam is often hammered after welding to give ductility and to smooth off the irregularities.

Malleable Castings

Malleable iron is white cast iron that was brittle but has been decarbonized so that it may be bent to a greater or less degree, as the less carbon in iron the more malleable the iron.

To decarbonize, pack the castings in some material that contains a large amount of oxygen, such as Hematite ore, heat the packed castings in a furnace, the time depending on the thickness of the casting. (From 5 days to 2 weeks is common.)

Most of the carbon is oxidized out from the casting by the packing material, leaving a crude wrought iron or mild steel, the depth of malleable metal depending on the time of treatment.

The process is used to produce parts cheaply with required shock-resisting qualities. Steel castings are used where more reliability and strength is required, but steel castings are expensive compared with malleable castings, hence the latter are used for pipe fittings, agricultural machinery parts, and other places requiring resistance to shock or subject to bending.

Malleable castings should be welded with bronze, except in a few instances in the case of light castings that have been thoroughly malleablized, in which case they may be welded the same as steel. Determine whether the casting has been thoroughly malleablized by trying with a cold chisel. If the chip curls, it indicates malleable iron.

A satisfactory job of welding results from preparing the joint by beveling as for steel welding; heat nearly to the fusing point and fill with Tobin bronze using a good bronze welding flux. This will give a joint that has a different color, but is strong.

Steel castings are castings made in molds from molten steel. The strains due to cooling are often excessive and, unless annealed, the casting is liable to break. Unannealed steel castings do not weld satisfactorily.

High carbon steel castings do not weld well. It is better to treat them the same as malleable castings, preheating when possible to avoid strains and to save gas.

Where it is desirable to weld steel castings to structural or plate steel, prepare in the usual way and weld, using filling material suitable for steel plate.

So-called semisteel does not weld satisfactorily except with cast iron.

Lubrication of Air Compressors*

Difficulties Encountered; Suitable Oils; Proper Quantities. By H. V. Conrad

SATISFACTORY lubrication of air compressor cylinders is attained by securing (1) the reduction of friction to a minimum and (2) elimination of carbonization of the oil as far as possible.

For the proper reduction of friction, the oil chosen should have sufficient body to sustain the weight of the moving parts and to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

The objections to air cylinder oils which allow more than the very slight amount of carbonization which appears unavoidable, are, of course, well known, but may be briefly stated for the purpose of clarifying what follows:

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

1. The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder.

2. The use of oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily and, therefore, remain too long upon the hot cylinder walls, etc., thus baking down to sticky carbon deposits.

3. The use of too great quantities of oil which has the same effect as the use of too heavy an oil as far as the carbonization is concerned.

4. The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonization aside from the sticking of air valves and choking of the air passages is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapor" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large depending upon how much carbon had been allowed to accumulate in the compressor and piping to the receiver. If these are kept properly cleansed at all times, there should never be a time of any danger.

This oil vapor is given off from a lubricating oil at a certain temperature called its "flash point" just as steam arises from water at a certain point.

Heat of Air Compression

The selection of an air cylinder lubricant is, of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table I.

TABLE I. CYLINDER TEMPERATURES AT END OF PISTON STROKE—INITIAL TEMPERATURE 60 DEG.

Air Compressed to	Final Temperature Single Stage	Final Temperature Two Stage
10 lb. gage	145 degrees F.	
20 lb. gage	207 degrees F.	
30 lb. gage	255 degrees F.	
40 lb. gage	302 degrees F.	
50 lb. gage	339 degrees F.	188 degrees F.
60 lb. gage	375 degrees F.	203 degrees F.
70 lb. gage	405 degrees F.	214 degrees F.
80 lb. gage	432 degrees F.	224 degrees F.
90 lb. gage	459 degrees F.	234 degrees F.
100 lb. gage	485 degrees F.	243 degrees F.
110 lb. gage	507 degrees F.	250 degrees F.
120 lb. gage	529 degrees F.	257 degrees F.
130 lb. gage	550 degrees F.	265 degrees F.
140 lb. gage	570 degrees F.	272 degrees F.
150 lb. gage	589 degrees F.	279 degrees F.
200 lb. gage	672 degrees F.	309 degrees F.
250 lb. gage	749 degrees F.	331 degrees F.

Relation of Oil Flash Point to Cylinder Temperature

The natural inference of the reader after noting the temperatures in Table I, is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case and it need only be carefully noted that: The study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc.

Qualities of Cylinder Lubricating Oils

For average normal conditions, the oil should be a medium bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base.

From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinder oils, provided that both have been properly filtered in the process of manufacture to remove the carbon forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light, fluffy nature and easily cleaned out, whereas, that deposited

* Copyrighted by Compressed Air Society, 1919.

by the paraffin base oil is very adhesive, and characterized by the hard, flinty nature.

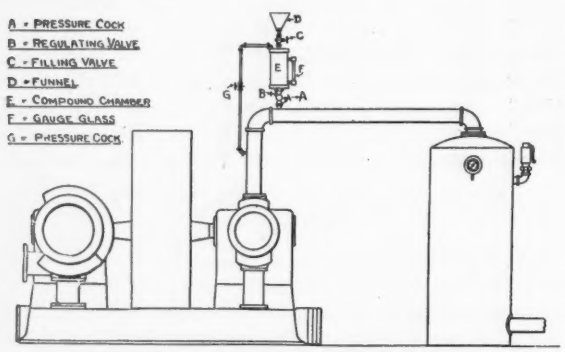
Paraffin Base Lubricating Oils

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air cylinder lubricant recommended for average duty, the following table is presented:

TABLE II. PHYSICAL TESTS OF PARAFFIN BASE OILS

	Minimum	Average	Maximum
Gravity, Baume..	28 to 32 deg. F.	25 to 30 deg. F.	25 to 27 deg. F.
Flash Point, Open Cup	375 to 400 deg. F.	400 to 425 deg. F.	425 to 500 deg. F.
Fire	425 to 450 deg. F.	450 to 475 deg. F.	475 to 575 deg. F.
Viscosity (Saybolt) at 100 deg. F.	120 to 180 sec.	230 to 315 sec.	to 1500 sec.
Color	Yellowish	Reddish	Dark Red to Green
Congealing Point (pour test deg. F.)	20 to 25 deg. F.	30 deg. F.	35 to 45 deg. F.

It is suggested that those oils within the range expressed by the minimum figures be used for light duty of low-pressure and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.


A = Pressure Cock
B = Regulating Valve
C = Filling Valve
D = Funnel
E = Compound Chamber
F = Gauge Glass
G = Pressure Cock
COMPOUND:—MIX 1 LB. OF RED SEAL LYE TO 15 LB. OF WATER.
To Use Compound: Close Cock "A" and "G," open Valve "C" and fill Compound through funnel "D," when chamber "E" is filled Close Valve "C," Open Cock "G" and "A" and Regulate Feed by Valve "B." Use about 70 Drops Per Minute

DEVICE FOR CLEANING CARBON IN AIR DISCHARGE LINE AND RECEIVER OF AIR COMPRESSOR

It is recommended that any paraffin base lubricant intended for use in "all standard air compressors," should meet the physical tests imposed by the average range of figures given in the middle column of the above table. The above wording "standard air compressors" is to be interpreted as including the following types of machines:

a. Low pressure up to 100-lb. compressors, which may be either small sized single stage units, or larger sized compound machines.

b. High pressure compressors which are constructed with the proper number of stages so that no excessive temperatures are ever reached.

Asphaltic-Base Lubricating Oils

This group of oils is considered separately for the reason that the lower limit of gravity stated in the above table, viz., 25 deg. baume, eliminates this entire group from consideration—which is not the intention of this article.

As a guide for the selection of suitable oil, the following table is given:

TABLE III. PHYSICAL TESTS OF ASPHALTIC BASE OILS

	Minimum	Average	Maximum
Gravity, Baume.....	20- 22 deg. F.	19.8-21 deg. F.	19.5-20.5 deg. F.
Flash Point, Open Cup	305-325 deg. F.	315-335 deg. F.	330-375 deg. F.
Fire	360-380 deg. F.	370-400 deg. F.	385-440 deg. F.
Viscosity (Saybolt) at 100 deg. F.	175-225 sec.	275-325 sec.	475-750 sec.
Color	Pale Yellow	Pale Yellow	Pale Yellow
Congealing Point (pour test)	0 deg. F.	—0 deg. F.	—0 deg. F.

For general all around use, it is conceded that the recommendations given in Tables No. 2 and No. 3 above cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

Proper Quantity of Lubricating Oils

The quantity of lubricating oil to feed to the air cylinders of compressors, cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table IV is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

TABLE IV. QUANTITY OF AIR CYLINDER LUBRICANT REQUIRED PER 10-HR. DAY

Diameter of Cylinder, In.	Size of Cylinder, In.	Displacement per Minute, Cu. Ft.	Piston Speed, Ft. per Min.	Sq. Ft. of Cylinder Wall Swept by Piston	Drops Oil per Min.	Drops Oil per 10 Hrs.	Sq. Ft. Oiled per Drop	No. Pints Oil Required per 10 Hr.*
8	8 x 8	120	344	718	1	600	718	.0375
12	12 x 12	320	408	1230	2	1200	613	.0750
18	18 x 18	880	496	2340	4	2400	585	.1500
24	24 x 24	1730	550	3450	6	3600	575	.2250
30	30 x 30	2940	600	4700	8	4800	590	.3000
36	36 x 36	4550	644	6070	10	6000	607	.3750
42	42 x 42	6700	696	7000	12	7200	633	.4500

* Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 deg. F.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to determine finally the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

Periodical Cleansing of System

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it.

For the removal of carbon, the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of one part soft soap to 15 parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about 10 times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made. After using soap suds, open the drain cock of the air receiver, and of the intercooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

Cleaning Air Receiver and Piping

It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these is shown in the illustration, where a receptacle made of 6-in. pipe is shown set on top of the discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixture of one pound of Red Seal Lye and 18 lb. of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe, and in the receiver, and if the blow-off valve on receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two, depending on how much accumulation there may be in the receiver.

Steam Cylinder Lubrication

The proper quantity of oil to be fed to steam cylinder is much greater than to air cylinders due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5000 to 8000 drops, and taking an average of about 6500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, as given in Table III, the recommended amounts to feed the steam cylinders or their equivalents are given in the following:

Table V—Quantity of Oil for Steam Cylinder Lubrication

No. Drops Per Min.	Size of Cylinder In.	Number Pints Oil Required per 10 Hr.
4	8 x 8	.4
8	12 x 12	.75
16	18 x 18	1.5
24	24 x 24	2.25
32	30 x 30	3.0
40	36 x 36	3.75
48	42 x 42	4.5

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

Observations on Changing Tested Oils

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collects on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubrication to the local experts of any reputable lubricating companies, and to be governed by their recommendations, which, however, should be based on the foregoing statement.

Reducing Operating Costs

Elimination of Leaks and Installation of Generating Set Puts Laundry Plant on Paying Basis

By Receiver

As the visiting engineer of the fuel conservation committee of one of the largest cities, a recital of conditions found in a steam laundry and how improved economy was secured may prove interesting to the readers of Power Plant Engineering.

The particular plant contained the usual complement of washers, dry rooms, tumbler driers, mangles, starch and soap kettles and water heaters.

Electric light and power were purchased from the local public service company, while, for the steam supply, two 66-in. tubular boilers were installed. Water was obtained from a near-by canal and the coal used was of a comparatively fair grade.

Trucks used for hauling the laundry were backed up to a platform which, although covered, offered no protection from the weather along sides and front, with the result that, due to the doors being open more or less of the time, the building became chilled and, as a consequence, considerably more steam was used than necessary. To prevent this state of affairs, the loading platform was entirely enclosed, and as the trucks were brought into this enclosure, the cold air was kept out of the laundry during the loading and unloading periods when it was necessary to keep the doors open.

As a further means to prevent the inflow of cold air, all crevices around window casings and door frames were pointed up.

All of the steam traps serving the various mangles and driers were found not only leaking, but discharging into an open tank outside of the building. To correct matters, new trap parts were ordered and put in place and all returns piped to a receiver, from which they were fed into the boiler. By these changes much additional heat was conserved.

The attendant, in order to attend to his various duties, such as making of starch, repairing belts, doing pipe work and operating an elevator, found it impossible to give his boilers the attention they required. When not

engaged at some other job, he would fill up his fire boxes and pump the boiler full of water, after which he paid no further attention to the plant until it was again necessary to fire up or the water had become dangerously low in the gage glass.

Investigation and analysis of operating costs made it apparent that the installation of a generating set would prove advantageous. Accordingly a single-valve automatic high-speed engine and a 150-kw. generator were purchased and installed.

The exhaust from the engine was well utilized. That not required for the heating of the boiler feed was passed through a hot water heater, after which it was finally disposed of in the dry rooms.

Reducing valves were employed to cut down the pressure of the boilers, 110 lb. to 50 lb. for the tumbler and mangles and to 20 lb. for the soap and starch kettle. Another reducing valve was used in connection with the heating system, thus providing a supply of live steam during cold weather when the exhaust was insufficient.

Boiler feed was taken from a near-by river. The amount fed was regulated by placing a suitable by-pass in the pump lines, thereby making it possible to keep the pump in continuous operation.

The amount of water used for washing was reduced by nearly half, which meant not only less water to heat but also less power to operate the machine and, to the surprise of all, resulted in a more satisfactory wash.

As work in a laundry varies from day to day, the steam pressure was lowered as the load on the engine fell off, which resulted in reducing cylinder condensation and losses due to leakage.

Continuous operation of the feed pump resulted in a less fluctuating water level, lesser strains on the boiler due to expansion and contraction, more uniform temperature of the feed and so more uniform steaming.

After the above changes were made, one boiler was capable of doing the work formerly done by two, and the attendant's time was wholly required at the plant. The results proved entirely satisfactory, and according to the records of the first three months, it was estimated that the economies effected by the changes made would, in the time of one year, pay for the investment made.

Pipe Standards and Their Application to Commercial Work

THEORETICAL STANDARDS; BRIGGS STANDARD GAGE; MAKING TIGHT JOINTS. BY A. M. HOUSER AND C. C. BARTLETT

MANY millions of screwed pipe joints are made every year in this country, and with the exception of the few casing threads used, they are practically all made using the American Briggs standard pipe threads. When it is considered that the threads used on the pipe and fittings are made by a large number of manufacturers and a large percentage of the threads on the pipe are cut by the consumer with tools made by other manufacturers, it is surprising how satisfactorily the threads interchange. This speaks well for the American Briggs Standard and proves that fundamentally this standard is correct and therefore all that is to be desired for making screwed pipe joints; in fact, there is no other standard in use in the world which is so well adapted to modern manufacturing conditions, allowing a satisfactory interchangeable product to be made with the least amount of effort.

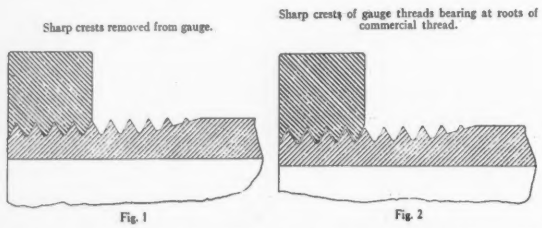


FIG. 1. EFFECTIVE DIAMETER OF PIPE THREAD CORRECTLY GAGED

FIG. 2. EFFECTIVE DIAMETER OF PIPE THREAD INCORRECTLY GAGED

To obtain a satisfactory interchangeable product the question of making gages properly is of vital importance. This is not only true in reference to American Briggs standard pipe threads, but of any standard, whether it be for pipe threads, bolt threads or any other style or quality of thread. In fact, any standard is only theoretical and incomplete until all dimensions pertaining to the gages have been definitely established.

AMERICAN BRIGGS STANDARD GAGES MADE TO GAGE COMMERCIAL THREADS PROPERLY

THE THEORETICAL Briggs standard thread has a depth equal to $\frac{0.8}{N}$ while a perfect "V" thread has a depth of $\frac{0.866}{N}$.

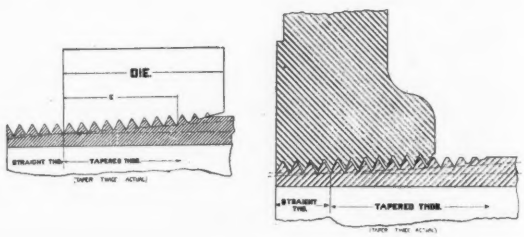


FIG. 3. INCORRECTLY CUT THREAD

FIG. 4. JOINT MADE BY NIPPLE SHOWN ON FIG. 3

Table II shows comparisons and the amount removed from the sharp crest and root of a perfect "V" thread to obtain the Briggs shape of thread.

Column 4 shows the depth of truncation on a sharp "V" thread necessary to produce the Briggs shape of thread. This comparison shows that while the Briggs Standard shape of thread has a flattened top it is very little removed from a theoretical sharp "V" thread.

The bottom of the commercial threads on fittings and pipe, as cut by the crests of a tap or die, is not

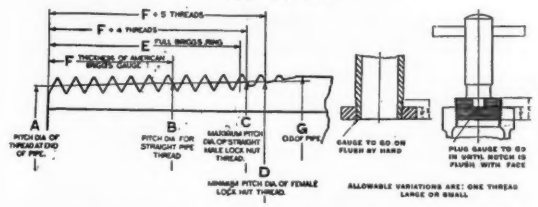
generally as sharp as called for by the theoretical Briggs standard shape. Generally speaking, this difference is not enough to affect the amount a pipe can be screwed into a fitting when making a tight joint, although it is sufficient to cause the practically sharp apex of the threads on a perfect theoretical gage to bear on the fillet left in the bottom of commercial threads, thereby not gaging the flanks of the thread, which is that part of the thread that determines how far the parts will screw together when made up.

The essential thing in gaging is to secure uniform assembly when the two commercial parts have been forcibly screwed together.

A Briggs standard gage having the true theoretical shape of thread will not properly gage the effective

TABLE I. AMERICAN BRIGGS STANDARD FOR TAPER AND STRAIGHT PIPE THREADS AND LOCKNUT THREADS

Adopted by the Committee of Manufacturers on Standardization of Fittings and Valves and the American Society of American Engineers September 17, 1913


F = 8 THREADS
F = 4 THREADS
E FULL BRIGGS FIRM
F THICKNESS OF AMERICAN BRIGGS GAUGE
A
B
C
G
D
PITCH DIA OF THREAD AT END OF PIPE
PITCH DIA. FOR STRAIGHT PIPE THREAD
MAXIMUM PITCH DIA OF STRAIGHT MALE LOCK NUT THREAD
O.D. OF PIPE
MINIMUM PITCH DIA OF FEMALE LOCK NUT THREAD
GAUGE TO GO ON FLUSH BY HAND
PLUG GAUGE TO GO IN UNTIL NOTCH IS FLUSH WITH FACE
ALLOWABLE VARIATIONS ARE: ONE THREAD LARGE OR SMALL

A equals $G-(0.05G+1.9)\times\frac{1}{N}+\frac{0.8}{N}$

B equals $A+(F\times.0625)$

C equals $B+\left(\frac{4}{N}\times.0625\right)$

D equals $B+\left(\frac{5}{N}\times.0625\right)$

E equals $(0.8G+4.8)\times\frac{1}{N}+\frac{.8}{N}$

F equals American Briggs Standard.
N equals Number of threads per inch.
Total Taper ¾ inch per foot.

Depth of Thread $\frac{0.8}{N}$

Size	A	B	C	D	E	F	G	Depth of Thread	Threads per inch
⅛	.36350	.37475	.38400	.38632	.2638	.180	.405	.02962	27
¼	.47739	.48989	.50378	.50725	.4018	200	.540	.04444	18
⅜	.61201	.62701	.64090	.64437	.4078	.240	.675	.04444	18
½	.75843	.77843	.79628	.80075	.5337	.320	.840	.05714	14
¾	.96768	.98868	1.00671	1.01118	.5457	.339	1.050	.05714	14
1	1.21363	1.23863	1.26036	1.26586	.6828	.400	1.315	.06956	11½
1¼	1.55713	1.58338	1.60511	1.61055	.7068	.420	1.660	.06956	11½
1½	1.79609	1.82234	1.84407	1.84951	.7235	.420	1.900	.06956	11½
2	2.26902	2.29627	2.31801	2.32344	.7565	.436	2.375	.06956	11½
2½	2.71954	2.76216	2.79341	2.80122	1.1375	.682	2.875	.100	8
3	3.34063	3.38850	3.41975	3.42756	1.2000	.766	3.500	.100	8
3½	3.83750	3.88881	3.92006	3.92787	1.2500	.821	4.000	.100	8
4	4.33438	4.38713	4.41838	4.42619	1.3000	.844	4.500	.100	8
4½	4.83125	4.88593	4.91718	4.92499	1.3500	.875	5.000	.100	8
5	5.30974	5.44930	5.48055	5.48836	1.4063	.937	5.563	.100	8
6	6.44010	6.50597	6.53722	6.54503	1.5125	.958	6.625	.100	8
7	7.43985	7.50235	7.53360	7.54141	1.6125	1.000	7.625	.100	8
8	8.43300	8.50003	8.53128	8.53909	1.7125	1.063	8.625	.100	8
9	9.42735	9.49797	9.52922	9.53703	1.8125	1.130	9.625	.100	8
10	10.54532	10.62094	10.65219	10.66000	1.9250	1.21	10.750	.100	8
11	11.53907	11.61938	11.65063	11.65844	2.0250	1.285	11.750	.100	8
12	12.53282	12.61782	12.64907	12.65688	2.1250	1.360	12.750	.100	8
14 O. D.	13.7750	13.87262	13.90387	13.91168	2.250	1.562	14.00	.100	8
15 O. D.	14.76875	14.87418	14.90543	14.91324	2.350	1.687	15.00	.100	8
16 O. D.	15.76250	15.87575	15.90700	15.91481	2.450	1.812	16.00	.100	8
17 O. D.	16.75625	16.87500	16.90625	16.91406	2.550	1.900	17.00	.100	8
18 O. D.	17.7500	17.87500	17.90625	17.91406	2.650	2.000	18.00	.100	8
20 O. D.	19.73750	19.87031	19.90156	19.90937	2.850	2.125	20.00	.100	8
22 O. D.	21.72500	21.86562	21.89687	21.90468	3.050	2.250	22.00	.100	8
24 O. D.	23.71250	23.86093	23.89218	23.89999	3.250	2.375	24.00	.100	8

diameter of a commercial pipe thread cut with a die that is even but slightly worn.

In order properly to gage the effective diameter of commercial pipe threads it is necessary to remove the sharp crests from the American Briggs gage, as shown in Fig. 1.

When gaged as shown in Fig. 2, it is possible to make male threads which will screw in up to the end of the thread or shoulder without making a tight joint on the taper. In other words, the effective diameter of the threads will be too small.

The above shows the possibility of error and the necessity of truncating the crests of the threads on the gage. This truncation when made $\frac{0.100}{N}$ should give general satisfaction.

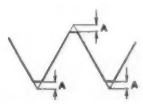
Making Tight Joints

THE MOST important function of a pipe thread is to make a tight joint, and therefore this should be the foremost thought when considering their practical and commercial applications.

The reference made to the slight rounding which is left on the bottom of the threads presents a problem of gaging only, and should be considered as such. This does not in any way affect the tightness of the joint or the amount a pipe screws into a fitting when made up.

TABLE II. AMOUNT REMOVED FROM CREST AND ROOT OF PERFECT "V" THREAD

1	2	3	4
No. of Threads per inch	Depth of Sharp "V" Thread	Depth of Briggs Thread	Amount Removed from each Crest and Root of a Sharp "V" Thread to obtain the Briggs Depth of Thread $\frac{.8}{N}$
27	.03207	.02962	.001225
18	.04811	.04444	.001835
14	.06185	.05714	.002335
11½	.07530	.06956	.00287
8	.10825	.10000	.004125



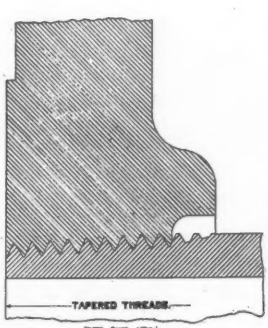
Column 2 = $\frac{.866}{N}$

Column 3 = $\frac{.8}{N}$

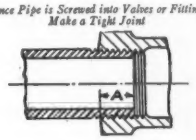
N = Number of threads per inch.

Column 4 = Dimension "A"

The theoretical Briggs shape of thread, which is very close to a sharp "V," is admirably adapted as a standard toward which to work, inasmuch as the almost sharp crests of a perfect thread will roll into a less perfect thread when made up, and help in making a tight joint.



Distance Pipe is Screwed into Valves or Fittings to Make a Tight Joint



Size Inches	Dimension A Inches	Size Inches	Dimension A Inches
⅛	¼	3½	1⅜
¼	⅜	4	1⅜
⅜	⅜	4½	1⅜
½	½	5	1⅜
¾	½	6	1¾
1	⅝	7	1¾
1¼	⅝	8	1⅝
1½	⅝	9	1¾
2	⅝	10	1½
2½	⅝	12	1¾
3	¾		

Dimensions given do not allow for variation in tapping or threading.

FIG. 5. JOINT CORRECTLY MADE

FIG. 6. DISTANCE PIPE IS SCREWED INTO VALVES OR FITTING TO MAKE A TIGHT JOINT

Sufficient tests have been made using threads with a flat equal to the U. S. Standard to prove that a larger percentage of leaky joints is obtained when the U. S. Standard shape of thread is used on the pipe than when the commercial Briggs shape of thread is used. This is no doubt due to the fact that a U. S. standard thread tends to leave an unfilled crevice at the tops and bottoms of the threads, while the Briggs shape of thread,

which is practically sharp, tends to roll into any irregularity, thereby readily making a tight joint.

The full Briggs length of thread, as shown under column E, plus the lead of the die, is the full length of the thread to cut on a pipe. The amount this thread should enter a fitting by hand is shown under column F. The difference between column E and column F represents the amount the pipe will make up by power plus an amount sufficient to allow reasonable manufacturing variation in the diameters of the male and female parts.

The Briggs length of thread as shown under column E is sufficient to allow making a tight joint, even should a large percentage of the thread be stripped when being cut. In fact, two or three perfect threads are sufficient to insure making an absolutely tight joint.

When a thread is cut longer than the Briggs standard, it is necessary with practically all dies on the market to run the thread through the die. The thread which projects through the die is consequently cut straight. This straight thread does not help but in most cases interferes with making a satisfactory joint, as illustrated in Figs. 3 and 4.

Figure 5 shows a joint properly made, using a length of thread equal to that called for by Briggs standard. In this case the flange shown in Fig. 5 has been recessed to receive this thread and allow the end of the pipe to

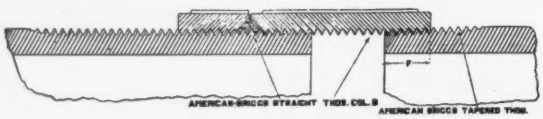


FIG. 7. LONG SCREW APPLICATION

come flush with the face of the flange for refacing and having all the threads in contact for the full length of the taper.

Normal Amount Threads Will Screw Into Fittings When Made Up

For handy reference, the dimension A of Fig. 6 and the accompanying table show how far a pipe will screw into a fitting when made up. This table is based on all parts being practically to gage, and a necessary allowance will have to be made if the parts gage large or small.

American Briggs Straight Pipe Threads

On some adaptations of pipe threads it is advisable to have a straight female thread which will receive an American Briggs taper male thread and make a pressure tight joint. One of these cases is in the application of the "long screw," which is chiefly used by plumbers. In this case it is necessary to have a long, straight thread on the nipple, which will enable the coupling to be screwed onto the nipple until it is flush with the end, and after inserting the "Long Screw" into place the coupling is then screwed forward until it engages the pipe to which the joint is to be made.

A tight joint is made between the straight threads of the coupling and nipple by means of packing placed between the coupling and a locknut, which is screwed against the coupling.

The size of the straight thread in the coupling as outlined above is standardized and known as the American Briggs straight pipe thread, shown under column B. The American Briggs taper gages should be used in determining the size of the coupling thread. (See Fig. 7, showing long screw application.)

American Briggs Male and Female Locknut Threads

This standard was established primarily for use on running threads where it is desirable to obtain the maximum thickness between the bottom of the thread and the inside diameter of the pipe, such as on a "tank nipple" application. Threads cut to this standard are larger in diameter than those shown in the "long screw"

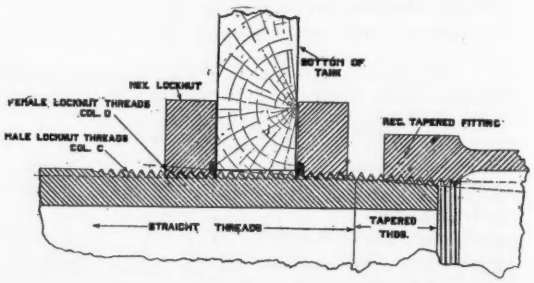


FIG. 8. TANK NIPPLE APPLICATION

application and are large enough to allow the cutting of a taper thread on the end of the pipe when it is desired; such as when a "tank nipple" is inserted through a tank and conditions require that a fitting be screwed onto the end of the nipple.

The thread on the "tank nipple" outlined above is known as the American Briggs male locknut thread, the maximum of which is shown under column C.

The thread on the locknut shown in this application is known as the American Briggs female locknut thread, the minimum diameter of which is shown under column D. Hexagon locknuts are used in "tank nipple" applications (see Fig. 8, showing "tank nipple" application).

Special Threads for Fixtures and Fittings

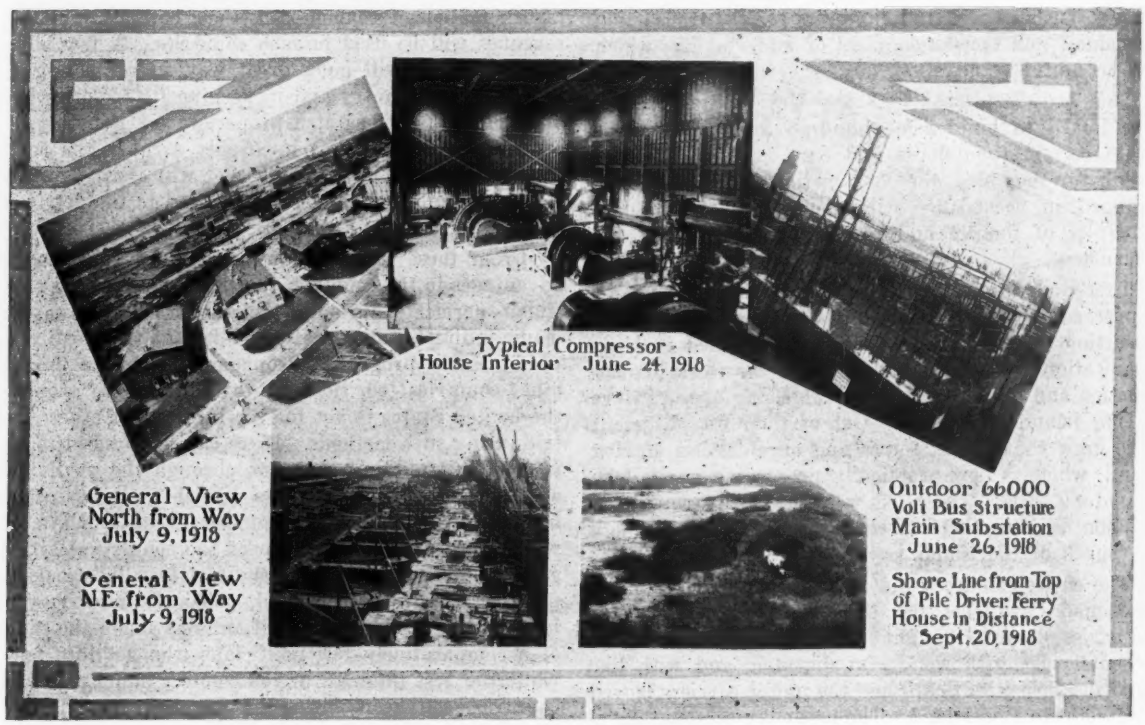
In 1915 the American Society of Mechanical Engineers established standards for threads to be used on gas and electric fixture fittings.—The Valve World.

U. S. Civil Service Commission announces an examination for assistant examiner in the Patent Office, for both men and women, on the following dates: March 26, 27, 28, 1919; May 21, 22, 23, 1919; July 23, 24, 25, 1919. Vacancies in the Patent Office Washington, D. C., at the entrance salary of $1500 a year, will be filled from this examination. Competitors will be examined in mathematics, including one or two questions each in algebra, plane and solid geometry, plane trigonometry, analytics, and differential calculus; mechanical drawings; French or German; technics, covering the general field of mechanics, mechanic arts, industrial arts and processes, and applied chemistry; experience; also, optional subjects: chemistry, civil engineering, electrical engineering, mechanical engineering, physics. Age 20 yr. or over on the date of examination. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

The Hog Island Shipyard

FACTS CONCERNING THE ORIGINATION, DEVELOPMENT AND FUTURE PROSPECTS OF THIS LARGEST OF ALL SHIPYARDS WHICH ARE OF INTEREST TO POWER PLANT ENGINEERS. BY A. P. CONNOR, WASHINGTON CORRESPONDENT

DEVELOPMENT of the Hog Island industry has been watched with interest by all the people of the country. The principal interest was the influence this industry would have upon the winning of the war. Those who have looked farther are anxious to see Hog Island develop to its fullest extent and help to place America in the first rank of shipbuilding nations, with which naturally comes increased foreign commerce, both export and import, and greater industrial activity. The shadow of doubt has been cast upon this enterprise by many criticisms charging graft, inefficient management and all manner of evils against those prominently responsible for its development.


Typical Compressor House Interior June 24, 1918
General View North from Way July 9, 1918
General View N.E. from Way July 9, 1918
Outdoor 66000 Volt Bus Structure Main Substation June 26, 1918
Shore Line from Top of Pile Driver Ferry House in Distance Sept. 20, 1918

SCENES PORTRAYING THE DEVELOPMENT OF HOG ISLAND INTO A MODERN SHIPYARD

These accusations have been investigated, and a report recently emanating from the Department of Justice shows them to be unfounded, and it is to be hoped that the country may now look with confidence and optimism at the rapid development and increasing output of this new enterprise.

To the engineer there could hardly be an industry the development of which would be more welcome than that of shipbuilding. It calls for engineers to man the ships—a complete crew for every new ship, in the case of Hog Island, every two or three days—all factories making equipment used on ships will benefit by increased demands, which in turn call for more power and greater dependency upon the engineers who produce that power. So readers of Power Plant Engineering may look for more and broader opportunities, increased responsibilities and greater prestige as the shipbuilding industry develops to its rightful proportions in America.

Now, as to Hog Island, it may be well to go into some details as to its origination, development and purposes, the general situation of which is pretty well known. The Hog Island shipyard was established near Philadelphia, provided with 50 ship-ways for the building of ships, and all the organizations and facilities to do the work, and under the strict general supervision of the United States Shipping Board, which is the source of governmental influence and control in the matter. It is the largest shipyard in the world, built at a cost, when completed, of about $61,000,000, and when at its scheduled capacity of turning out ships it will present a ship every other day for use in the carrying of the people and products of the world. It was built in a marshy district, known as Hog Island, on the apex of Chesapeake Bay.

During an interval of a week which the writer spent at these yards he saw ships grow from nothing to monsters of 7000 and 8000 tons size; large industrial buildings seem to rise overnight; and large structures, such as cranes, derricks, towers, etc., of large capacities are continually springing up with marvelous speed to the completed form. The result is there now exists a shipyard of several miles area, covered with buildings, machine shops, railways and industrial equipment, and

bordered with a line of majestic and stupendous shipways, some a mile and a half long, and populated with workers, and all that goes with such an industrial existence in an up-to-date development of this nature.

Who Produced Hog Island

Hog Island was the outcome of a combination organized by bankers, business men and engineers of the United States into a body called the American International Shipbuilding Corporation, the objects of which were definitely aimed to be:

First. To establish friendly commercial relations with all countries of the world.

Second. To participate in the development of such enterprises—domestic and foreign—as will broaden the scope of American activities and lead to a better understanding of international relations.

Third. To promote the organization of corporations or associations to bring together foreign and American bankers, business men and engineers for the transaction of business and the development of undertakings which will be mutually advantageous.

This body arranged with the United States Shipping Board to build some hundred and thirty ships within certain time limits and costs. The manner of paying for the ships, the construction of the yard was arranged in accordance with definite and up-to-date principles of finance and in complete control of the government.

This corporation, after receiving definite instructions to proceed, called in the facilities of Stone & Webster, consulting engineers, and they in turn called in their organization and immediately started the work of construction and the fundamental establishing of the future of Hog Island's existence. Out of their establishment there grew the present forces and organization of Hog Island, which is now practically proceeding on its own individual basis. The yard was practically completed ten months after the first surveyor ran a line through the length of the island.

The entire resources and agencies of the government were made available for this enterprise. The War Industries Board brought piling, ties and rails to the enterprise with wonderful dispatch, and with like speed the Priorities Board and the public carriers moved the freight to Hog Island. The best engineers and naval architects and purchasing officers of the Emergency Fleet Corporation were at the constant disposal of the enterprise. Manufacturers throughout the country offered freely their facilities on the theory of aiding a war-time government project.

Thus the achievement at Hog Island is not that of any single organization, but the collective achievement of the entire country.

The Location

The location of Hog Island is exceptionally good. In the first place, it is within the district in which over 50 per cent of the war material of the country was being made. It is close to the coal and steel centers of the country, and within easy access of all the ports of the Eastern coast, and still exceptionally well protected against a sudden military onslaught. The market for skilled and unskilled labor surrounds the district. It is a practical center for railroad facilities, as well as shipping. In fact, there does not appear to be a more suitable location for it on the Atlantic seaboard.

Should Shipbuilding Be Encouraged?

There are several items of interest in the matter of shipbuilding that concern the country and every branch of its industry deeply. If the United States should see fit to discourage shipbuilding, then several effects will result: first, the ships will be built elsewhere; in fact, other countries have jealously done so in other years, and still want to do it, at our expense, if need be. The second result will be that the material and the industry required for the building of the ships will not be produced in the United States, but in the countries building the ships, and our factories and our labor will lose accordingly and show the effects. Third, the countries with the ships will receive and use the revenues for the transportation of commerce in their bottoms, and these revenues will be used in such countries. A few billion dollars a year will go a great way in promoting the interests of a country and in keeping its factories busy and men in positions at a proper wage. Fourthly, the countries with the ships invariably arrange the routes of transportation in a manner that will assist their own countries' commerce and interests, and to the detriment of all those countries that are dependent thereon.

From these items follow a series of supplemental advantages to the countries that build and use the ships, which permeate through the countries and improve many indirect industries and interests that ordinarily would barely progress. Propaganda has been used by other countries (so 'tis said) to influence the people of the United States to act for the interests of other countries using such methods. If we can be induced to give up our shipbuilding program, through the medium of apparent scandals, labor laws (which react against the interest of labor), or other means, then our interests will suffer, and the wise men of the country seeking to guide the country right in the matter will become unpopular. On the other hand, political phases may enter, and the national issue of interest made the victim of a comparatively few politicians who get into power while the best interests of the country suffer. If other countries can keep down our merchant marine, it is also safe to state that they will also keep down our navy, and our protection as well as industrial activities will be accordingly affected.

The writer considers it of vital interest to the welfare of the country that Hog Island should be promoted to its fullest now, not only because ships, "and ships and ships" are needed by the world, but also to forestall any threatened depression in our industrial world that may arise with the return of soldiers demobilized, the stoppage of war contracts and the timidity of manufacturers who may curtail, due to shutdown of war activities and other inducements that kept them overloaded such a short time since.

Shall he who cannot do much be for that reason excused if he do nothing?

Abraham Lincoln.

Refitting Corliss Valves

HAVING HAD occasion to rebore Corliss cylinders and valve ports during our road experience, a description of some of the more important details may be of interest.

Figure 1 illustrates a type of valve and stem that was made some years ago. It is seen that the stem goes the full length of the valve and has a bearing in the back bonnet. Either a flat or spiral spring was inserted in holes in the back of the valve and bore against the stem, and, as some builders claimed, allowed the steam valves to rise off their seats and relieve the cylinder of a dose of water.

When one considers that water might enter a cylinder in sufficient quantity to force the valves off their seats, one can imagine what the result would be. The water would be admitted into the other end of the cylinder through the steam port the next time the steam valve opened and only a limited relief if any would be realized.

With this style of valve and stem it was necessary to remove the valve gear and take out both valve and stem to examine the valve and seat.

With the modern valve and stem, Fig. 2, which has a tee head fitted into a slot in the head of the valve, the valve is easily removed for examination by removing back bonnet, inserting the proper eye bolt in the tapped holes in the valve head and redrawing the valve. The valves are much lighter than the older design and so move with less friction and wear.

It is the usual practice to turn the valves several thousandths smaller than the diameter of the bored part to allow for expansion and to let the valve rise from the seat should water enter the cylinder.

Figure 3, exaggerated, illustrates the result. The valves have only a line bearing on their seat which is really the whole area of the working face of the valve and the two heads. The metal surfaces in actual contact are so small that wear and wiredrawing of the steam soon cause excessive leakage, even if the valves were tight in the first place, which is seldom the case.

We have always turned our valves to such a diameter in relation to the port diameter that the valves were driven into their ports with a heavy hammer. The valves were then offset and a light chip taken off the heads to ease the valves slightly. In this manner the radius of the valve face and port are the same and the valves soon become tight and having larger bearing surfaces remain so much longer than when the other method of fitting is followed.

No matter how good a job is done in fitting valves, they will warp, and so not remain tight. In the case of the steam valves as long as the engine is running the backs of the steam valves are subjected to the temperature of the initial steam and the lower faces have a portion of the stroke when such surfaces cool somewhat. A similar condition exists for the exhaust valves only it is the exhaust temperature in the exhaust chest on the back of the valves continually.

After the valves have run about 2 weeks it is good practice to remove the valves and draw-file or scrape down the high places as examination reveals them.

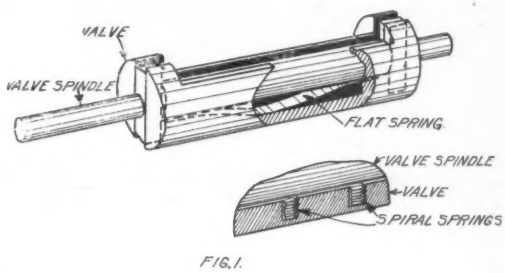


FIG. 1.

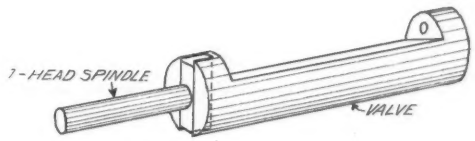


FIG. 2

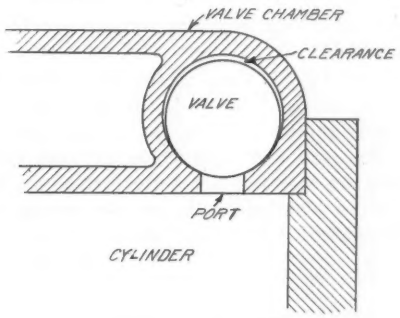


FIG. 3

FIG. 1. OLDER TYPE CORLISS VALVE
FIG. 2. MODERN TYPE CORLISS VALVE
FIG. 3. CLEARANCE ALLOWANCE BETWEEN VALVE AND SEAT

Carefully following this procedure and patience will lead to a steam tight job and is the only way to secure desirable results. Of course when the valves are fitted thus when the engine is first started the leakage will be greater than when the valves are not hand fitted, but after running a short time and things obtain their running temperature the valves will be tight.

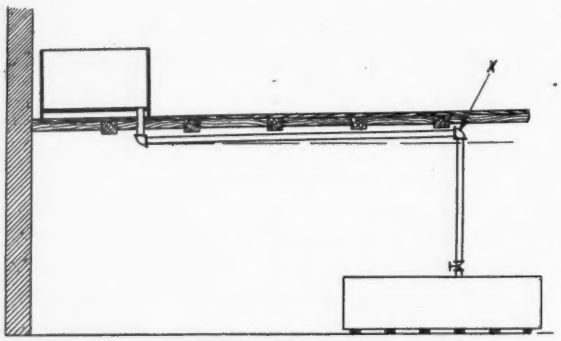
One of the best ways to spline a valve stem is to

assemble the valve gear complete in position and with wristplate central and valves given the proper lap or lead scribe the location of the spline on the stem, using the spline way in the crank as a guide.

RECEIVER.

Air Pocket Prevents Water Flow

AIR BINDING is a frequent cause of trouble in connection with water piping, though as a general rule this factor is overlooked. In one plant with which the writer was connected a supply tank was located on the second floor, from which a pipe led to a dye tub on the first floor on the other side of the building. Though the head of water between the two tanks was small, still it was amply sufficient theoretically to discharge the required amount of water, but in spite of this difficulty was experienced in maintaining the water supply to the lower tank at times, and we were about to run a larger size pipe line in order to secure more capacity. As we were measuring up for the new pipe, I noticed



RISE IN PIPE LINE WHICH CAUSED AIR POCKET

that there was a considerable slope to the horizontal pipe. It was found to be about 12 in. higher at the discharge end, as shown in the sketch. It then occurred to us that this pocket at a high point in the line provided an admirable chance for air to collect and retard the flow, especially in view of the slight difference in pressure. We immediately arranged to lower the high end of the pipe and to provide the slope in the proper direction, following which a full free flow from the pipe was obtained. Where any pockets are thus formed in water lines and it is not possible to change the piping a pet cock should be provided to relieve the air from time to time.

M. A. SALLER.

A Large Hack Saw

SIXTY years ago, and even later, the hack-saw was the most ill-used tool in a workshop. It was soft enough to be sharpened with a saw file, and was very soon blunt. No one would sharpen it after use, so filing it was preliminary to using it. The teeth had no clearance beyond the rough side produced by the file, and so a deep cut was a laborious business that no one liked. The modern hack-saw is a different tool and has effected extraordinary economies in the workshop. It is made of a high quality of steel having great durability, and, when handled with reasonable care, will do an enormous amount of work before being worn out. Fitted in a sawing machine in which the speed, movement and pressure are carefully regulated, it will cut up round and square bars to finished lengths that require no further treatment.

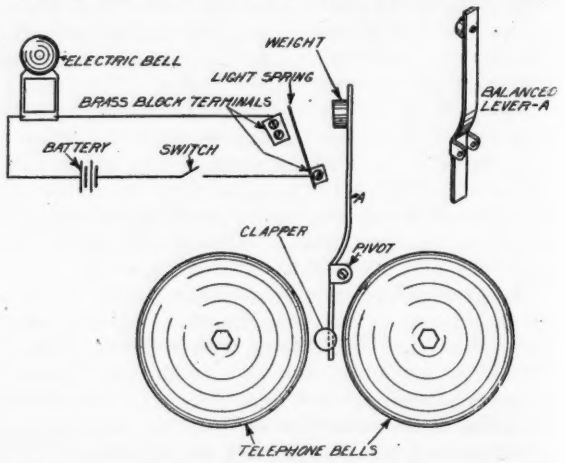
In course of time, the size of the work it would undertake grew beyond anything at first contemplated, and today there is in use at the Royal naval gun factories in England a set of five motor-driven hack-saws that will deal with all hardened bars of gun steel 15 in. in diameter. They are looked after by one unskilled man and a woman. A larger machine has recently been added to the outfit of the same works. It weighs 3½ tons and will cut through a 26-in. square billet of steel with one blade that still remains serviceable. A 3-hp. motor drives it. The cost of sawing is only 1/6 of the cost of the method previously employed. At the present time there is as much competition in hack-saw blades as in files, so that their price remains so moderate that no well-appointed workshop can afford to be without them.

It must, however, be noted that the modern hack-saw is not fool-proof; it can be spoiled in less than a minute by any stupid workman who, using it like a file, may rub the teeth off in a few strokes. The user should begin with a slow and steady stroke at a very moderate pressure, using the whole length of the saw until it is properly entered into the metal. The pressure may then be increased to a moderate degree; but it should never be excessive, as the saw consists of a row of very small cutting points that are highly tempered and not meant for rough work. Rightly used, the hack-saw will save a great amount of filing and chipping representing time that is convertible into money.

MARK MEREDITH.

A Readily Constructed Telephone Extension Bell

THIS easily-built and set up apparatus will be found very handy for those who experience difficulty in missing telephone calls which may be of importance to them



TELEPHONE EXTENSION SIGNAL AND METHOD OF APPLICATION

when they are within answering distance of the call had they known it was made. The apparatus consists primarily of a balanced weight, which is mounted on

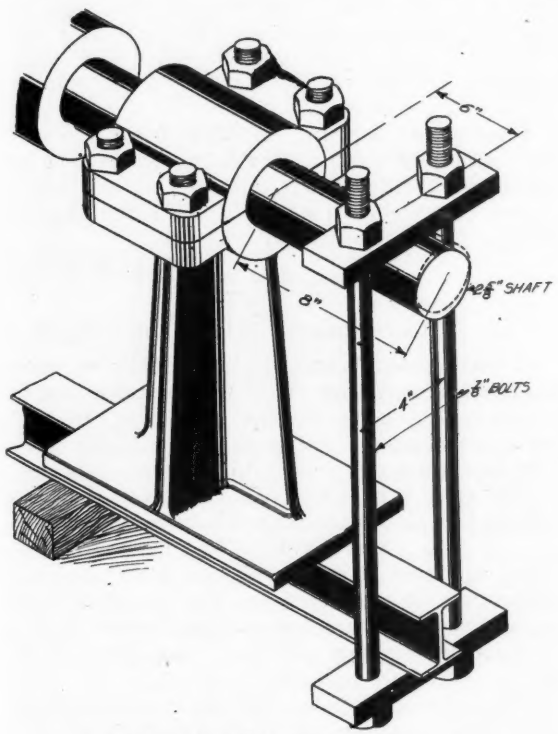
the phone itself and is actuated by the bell clapper, a common electric door bell, two dry cells, a switch and an easily-made contact maker. The balanced weight is fastened to the end of a lever which can be constructed of a single piece of brass.

The contact maker is made from a light spring, fastened to a brass block, which, when depressed, rests upon another like block or terminal.

The switch should be installed near the phone, and is to be used to open the circuit any time that a person is not to be out of hearing distance of the phone bell. The balanced weight should be reset upon answering the call. The batteries can be located in any out-of-the-way place. The bell will, of course, be located in any dry place where it can be heard by the person wishing to answer the phone. W. W. PARKER.

Straightening a Shaft

AS A result of an accident in our plant the shaft projecting out of the bearing and carrying a gear came out of line. The illustration shows clearly the method we have employed for the purpose of bringing in line the deflected portion of the shaft. We had in stock



METHOD OF STRAIGHTENING SHAFT

⅞-in. bolts, and figured that the section of 2⅞-in. bolts was sufficient to stand the tension; the thread of the bolts was nevertheless in danger.

To be on the safe side we kept on hammering on the shaft near the bearing while tightening the nuts, and the job was safely done. R. A. WACHUTIN.

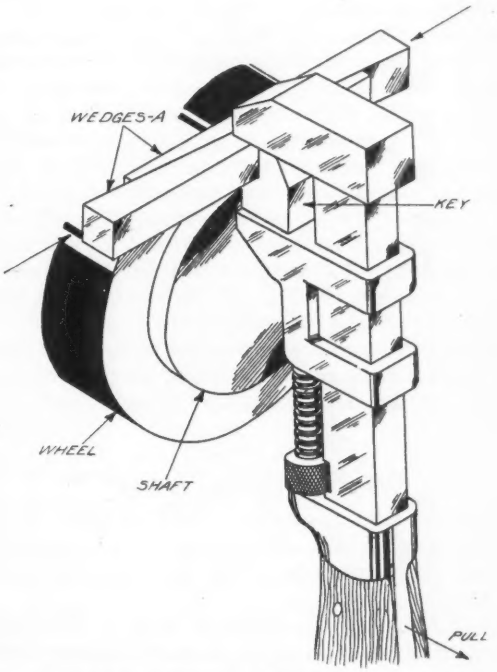
Covering for Tops of Boilers

A GOOD, cheap and efficient covering for tops of boilers, so that the heat losses from this source can be reduced to a minimum: First cover top of boiler with coarse ashes from 6 to 8 in. thick; then cover this with a cement consisting of four wheelbarrows of coarse ashes, one bag Portland cement, one bag of asbestos cement thoroughly mixed dry, and wet. This makes a top sufficiently hard to walk on.

JESSE BARRETT.

Method of Extracting Key

THE METHOD of extracting a key, illustrated herewith, is both simple and effective, and requires few tools, a monkey wrench and 2 wedges. I have often used cold chisels for wedges. Place wedges as shown at A, and



REMOVING KEY BY MEANS OF WEDGES

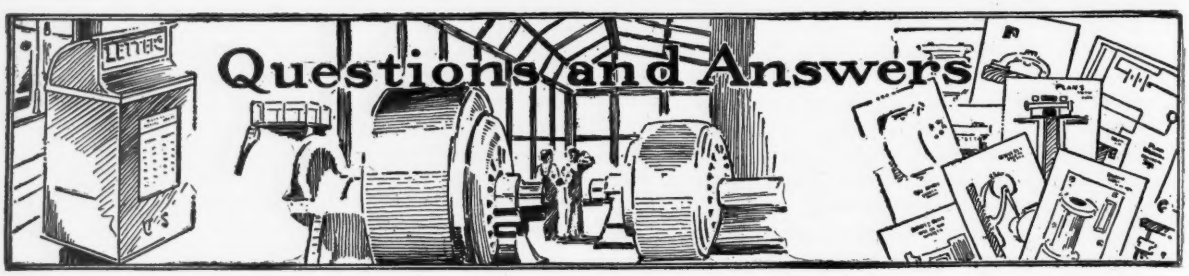
hold with the wrench; drive wedges together. If the gib on the key is of sufficient strength, the key will come out. I have often tried this method, and it has never failed. TOM JONES.

Preventing Decay of Piling

ROCK SALT is being used in an interesting manner to preserve creosoted wooden piles supporting low trestles on an American railway. A shallow, open-top box is built around the head of each pile and fitted loosely; each box is then filled with rock salt. Occasional rains supply the receptacles with water. The strong saline solution thus formed escapes from the boxes and covers the piling. In this way the timbers are automatically treated at frequent intervals, and their decay is prevented, or at least considerably delayed.

TEACH ECONOMY; that is one of the first and highest virtues. It begins with saving money.

ABRAHAM LINCOLN.



A Corliss Valve Setting Problem

I HAVE a question relative to the setting of the valves on a 28 by 48-in. double-eccentric Murray Corliss engine which I desire to put up to the readers of Power Plant Engineering for answer.

Assume that the eccentrics have been properly set, rocker arms and wristplates adjusted and the steam valves set with the correct lead and the exhaust valves giving the proper degree of compression. Is there any difference in the required setting of the governor when it is desired to cause the steam valves to cut off at ¾ stroke as compared to cut off at ½ stroke?

I maintain there is, and in setting of cutoff at ½ stroke I think the governor should be midway of its travel, while for cutoff at ¾ stroke I maintain it should be so set as to cause release of the steam valves when at its lowest running position.

Will somebody please furnish me with correct directions for the setting of the valves and the proper adjustment of the governor on this kind of an engine?

T. J. B.

Why the Leaky Tubes?

WE HAVE at our plant three 7 by 20-ft. Casey Hedges return tubular boilers, each having 105 4-in. tubes and carrying 135 lb. pressure. They have been in continuous use about 5 yr.

These boilers supply steam for a 28 by 48-in. long-range Corliss engine, a 16 by 20-in. oscillating cylinder twin engine, a 10-in. by 48-ft. steam feed cylinder, a dry kiln with about 34,000 ft. of 1-in. pipe and all the necessary apparatus that go with a double circular sawmill.

I wish some of the readers of Power Plant Engineering would make a rating of these boilers, and also tell me why every few days the tubes of one or the other boiler leak; sometimes all the tubes leak, sometimes half of them and sometimes only a few.

The first few years, when the boilers were new, we had no tube trouble, but this started about 2 yr. ago. We had the tubes of one boiler renewed, but it does not eliminate the trouble. The feed water is not scaling very much and we wash out once a month.

I would be greatly obliged to anybody who can tell me the cause or offer a remedy for this tube trouble. Probably some reader has or has had the same trouble.

A SUBSCRIBER.

Kerosene for Scale Removal

IN REPLY to the inquiry of A. B. V. appearing in the Feb. 15 issue regarding the use of kerosene in boilers, I may say that after taking over the management of this plant about 18 mo. ago, I made it a rule to inspect boilers after every washing. I go over each boiler thoroughly. On my first inspection, I found that the flues were quite scaly, although we use a compound made up expressly for this water. I watched this compound closely and found that after the scale was off, it kept things fairly clean; but it had no effect on scale that was already formed. I then thought of using potatoes, but decided on using kerosene, and use a quart to each boiler after a wash-out, making it a point to wash each boiler every two weeks. In my estimation, it is the only thing if you have to contend with dirty water. I would further suggest that if water is dirty blow your boiler off every 2 hr. for about a minute at a time, also your manifold blowoff at same time. This will keep water in circulation and I find that boilers are much cleaner at the end of every two weeks.

C. BRAZIL.

I HAVE USED kerosene in boilers for a number of years with good results. The boilers of which I have charge are 72-in. by 16-ft. units, 8 yr. old, and are cleaned out every two weeks. I use about ½ gal. of kerosene in each boiler every other day.

J. A. MCQUEEN.

U. S. Government Safety Valve Rule

YOUR REPLIES to inquiries are usually so correct, lucid and authoritative that I was somewhat surprised to find the rule given on page 173 of the Feb. 1 issue for the calculation of safety valve sizes. This rule has been superseded now at least 15 yr. by the following:

The areas of all safety valves on boilers shall be determined in accordance with the following formula:

$$A = 0.2074 \times (W \div P)$$

where A = area of safety valve, in square inches, per square foot of grate surface; W = pounds of water evaporated per square foot of grate surface per hour; P = absolute pressure per square inch (that is, working gage pressure plus 15).

Multiplying the value of A as thus determined by the number of square feet of grate surfaces will give in square inches the area of safety valve or valves required. When the calculation results in an odd size, use the next larger standard size of valve.

T. T. MERSEREAU,
INSPECTOR BUREAU OF NAVIGATION, STATE OF NEW YORK.

Operating Alternating-Current Machines in Parallel

I WISH to take exception to the answer given L. B., page 171 of the Feb. issue of Power Plant Engineering. You say, "If the machines are of like rating, then the

load would be equally divided between the two machines; but if they are not of like rating, then you will have to adjust your rheostats so that each machines carries its proper proportion of load."

Two machines of like rating running together will not always divide the load equally. Changing the rheostats will not change the load on either of them, but the amperes will be changed owing to a change in power factor. The way to change the load on an alternating current generator running in parallel with another of like or different rating, is to change the speed. If two machines of like rating are running at the same speed, then the load will be divided nearly equally.

We can and do run an 850 kv.a. machine in on a 150,000-kw. system and carry any load up to the capacity of the machine without touching the field rheostat except to change the power faetor.

W. H. MOORE

ON PAGE 171 of the issue of Feb. 1, L. B. has an inquiry relative to the operation of alternators in parallel and proper division of load; your answer will apply to direct current generators, but does not to alternators.

Load division of alternators operating in parallel is controlled by the governors on the prime movers. Changing the field strength of one without changing that of the other causes cross currents to be set up between the machines, but does not shift the load.

For L. B.'s problem I would suggest that if possible he operate his exciters in parallel, then adjust his rheostats in alternator fields so as to get the least cross current (highest power factor), then regulate the voltage by raising or lowering voltage of exciters.

If he desires to use an automatic regulator, he would possibly get better results by installing an exciter large enough to take care of both alternators.

RANDOLPH M. ROUK.

Why the Difference in Cards?

REGARDING the crank-end diagram of the card A, from all appearances, I should judge that the drum of the indicator had been brought up against one of its stops very abruptly to merge the compression and admission lines into one, as their appear in this diagram.

Were it not for the fact that the two cards were taken about 15 min. apart, B being a very fair card, one might be led to assume that the exhaust valve on that end needed adjusting very badly. It is hard to state the exact cause leading to such a diagram without being acquainted with the manner in which it was taken. It might possibly be that the indicator cord was of the wrong length or stretched or that the reducing motion was not accurate, allowing the drum over which the card was stretched to meet one or the other of its stops at the end of the stroke which it should never do.

Regarding diagram B, a few adjustments of the valves, both steam and exhaust, if it is of the automatic cutoff type or the valve stem or eccentric, if of the old style slide valve type, would insure a little more economical and quieter running engine. J. W. S.

REGARDING the indicator cards submitted by J. M. L. and published in the Feb. 1 issue, page 170, I would say that the crank end of card A is incomplete. The lower card is reasonably good and was taken within 15 min. of card A. I suppose no alterations of any kind were made in the valve setting, and not stated otherwise, the load was practically the same in both cards.

In the lower card the crank end is doing the more work, while in card A the head end is doing more—apparently. But if we notice the crossing of the expansion lines, in both cards, they are similar; that is, the point of intersection is nearer the head end than crank end in both cases. This can easily be seen if the distance is measured from point of intersection of expansion line, up to points of intersection of expansion and atmospheric lines. I think this is conclusive proof that the head end cards are the same proportion to the crank end cards in both cases.

Compression is shown on the crank end of the lower card, while none is shown in A, and in this card the steam line is shown more nearly vertical.

Card A is longer, also than the lower card.

Judging from the evidence, it seems to me that a different bushing was used on the reducing wheel, giving a different length to the card. I would not say which was taken first, but when the card A was taken the indicator cord was not properly adjusted to give full motion to the paper carrying drum, and this drum ceased to revolve before the end of the stroke, causing the crank end card of A to be incomplete, or imperfect.

If the load were balanced between head and crank end, and compression made about the same, it might improve the card, but on the whole, for an engine in service 29 yr. with no repairs, the lines show well.

TOM JONES

IN EXAMINING the cards submitted by J. M. L. and as published on page 170 of the Feb. 1 issue, it appears as if the man who took card A was not careful enough with the reducing motion. It is noticeable that cards A are somewhat longer than those marked B.

Evidently in producing the crank end card of set A the barrel of the indicator was pulled all way around until it hit the stop before the engine had completed its strike, and as a result was not moving at the time compression began. It also must have remained stationary while steam was admitted to the cylinder, thus producing the square corner; further evidence of this is seen in the comparatively short cutoff on the crank end.

The second or B set of cards taken by the other man are shorter and are good, considering the length of time the engine has been in service without repairs having been made upon it. S. J. S.

Measuring Water Flow by Weirs

IF YOU CAN give me a simple formula for measuring the amount of water by the use of a weir I would appreciate it. The discharge is from a 6-in. pipe into a ditch. We placed a box with an 8-in. wide weir at one end of the box under the discharge and the water flowed over the weir 1½ in. high. E. L.

A. You may readily solve your problem by the application of the Francis formula, which is as follows:

$$Q = 3.33\ (l - 0.2\,h)\ h^{\frac{3}{2}}$$

where Q is the number of cubic feet flow per second, l is the length in feet, and h is the height, also in feet.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Office

(Established over 23 years.) Formerly PRACTICAL ENGINEER
PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago
New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1919, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue 22,200.

CONTENTS

Engineering for Education. Illustrated....223
Steam Turbine Operation. By J. B. Wilson. Illustrated..227
Steam Expansion—I. By Roger Taylor. Illustrated....232
Worcester's Fuel Saving Campaign. By S. E. Balcome. Illustrated....236
Control of Combustible and Air in Burning Powdered Coal. By W. G. Wilcox....237
Characteristics of Electric Motors—III. Illustrated....240
Dipping and Baking as a Financial Asset. By J. S. Dean. Illustrated....243
Oxy-Acetylene Welding—II. Illustrated....244
Lubrication of Air Compressors. By H. V. Conrad. Illustrated....247
Reducing Operating Costs. By Receiver....247
Pipe Standards and Their Application to Commercial Use. By A. M. Houser and C. C. Bartlett. Illustrated....250
The Hog Island Shipyard. By A. P. Connor. Illustrated..253
Letters Direct from the Plant: Refitting Corliss Valves. Air Pocket Prevents Water Flow. A Large Hack-Saw. A Readily Constructed Telephone Extension Bell. Straightening a Shaft. Covering for Tops of Boilers. Method of Extracting Key. Preventing Decay of Piling. Illustrated....255
Questions and Answers: A Corliss Valve-Setting Problem. Why the Leaky Tubes? Kerosene for Scale Removal. U. S. Government Safety Valve Rule. Operating Alternating-Current Machines in Parallel. Why the Difference in Cards? Measuring Water Flow by Weirs....258
Editorial: Training Tools. The World Moves. Meterology....260
Prize Essay Contest in Industrial Economics....261
New Traveling Grate Stoker for Forced Draft. Illustrated....262
Jeffrey Loaders Serving Power Plant Needs. Illustrated..263
New Notes....264

Training Tools

One of the questions frequently discussed in connection with readjustment problems is the disposition to be made of the great numbers of machine tools in the possession of the Government, which were bought to equip war factories.

Factories here and abroad are, for the most part, well supplied with such tools as they need for peace time manufacturing, so that a long wait, or junk prices would seem to await any attempt to dispose of this surplus through the usual channels.

Nor is it desirable that the Government be for a long period in the market as a competitor of tool manufacturers, offering a large stock of tools at prices, lower even than the cost of manufacturing.

For a long time there has been a lack of well-trained mechanics, and a great number of youths with no trade training seeking to enter industry, but having only scattered and inadequate means of securing training. The hindrance to the establishment of vocational training in many schools has been the cost of securing the needed tools.

In other countries the governments have fostered trade training, and schools for this purpose are numerous and efficient. The present situation gives opportunity for us to start a trade school in every community, equipped with the latest and best tools, and at a cost which the community can afford. Much of the equipment now owned by the Government is suitable for such schools. A committee of vocational educators could easily select this and it can then be set aside for loan to boards of education, universities or colleges that wish to equip schools and that furnish satisfactory evidence of buildings and funds to carry on the work. Such tools as are not taken for school work after 2 yr. can be disposed of on the market. This plan, which is advocated by those most deeply interested in the industrial success of the country and in progressive education, will furnish a method of giving every boy who wishes it a chance for a thorough trade training, as well as solving a difficult Government problem.

House Bill 15625 authorizes the Secretary of War to lend these tools on the basis outlined and it is to the interest of our children and our country that Representatives and Senators be urged to support it.

The World Moves

The sight of an operating engineer standing on the platform of crowded Tremont Temple, Boston, at a recent session of the congress on behalf of a League of Free Nations, and as chairman presenting to the audience our distinguished Ambassador to Germany that was, proved a goodly one to those who believe that the time has arrived for the technical man to take his proper place in large public affairs. Even the presence of a beloved ex-President of the United States as a leading speaker on the program did not appear to disturb the composure of the presiding officer, whose conduct of affairs resulted in a meeting of unusual freedom and success. There is, of course, no question of profession or occupation involved in any man's ultimate fitness to move among famous people and to direct affairs in

which persons of world-wide note take an active part. But the operating engineer has so long been looked upon as a humble individual of near-janitorial interests that it is both gratifying and prophetic to see engineers taking hold of great causes with the concentration and enthusiasm so often applied in their vocational work, but so frequently hid under the bushel of daily routine restrictions.

Meterology

Are you in step with modern "ologies"?

Meterology is a science that is receiving increased attention because of the rapid development of aerial navigation. It is a knowledge of the principles governing the variations in atmospheric pressure and temperature—changes which are of great use in forecasting weather—gustiness and wind directions, cloud formations and possibilities of squalls and disturbances. Sea and air pilots are governed by its advices.

Meterology is a popular science followed by boiler room skippers who wish to avoid squalls on the log sheet. Its influence and favor are fast widening. Metering coal, feed water, and steam eliminates hazardous guesswork, enforces economy and safeguards service. It permits of analytical comparisons, simplifies, clears away the cloud of obscure performance and forecasts progress. It merits a wider application.

Prize Essay Contest in Industrial Economics

THE National Industrial Conference Board offers a prize of $1000 for the best monograph on any one of the following subjects:

1. A practicable plan for representation of workers in determining conditions of work and for prevention of industrial disputes.

2. The major causes of unemployment and how to minimize them.

3. How can efficiency of workers be so increased as to make high wage rates economically practicable?

4. Should the state interfere in the determination of wage rates?

5. Should rates of wages be definitely based on the cost of living?

6. How can present systems of wage payments be so perfected and supplemented as to be most conducive to individual efficiency and to the contentment of workers?

7. The closed union shop versus the open shop: their social and economic value compared.

8. Should trade unions and employers' associations be made legally responsible?

The Committee of Award is composed of: Frederick P. Fish of Fish, Richardson & Neave, Boston, Mass., Chairman of the National Industrial Conference Board; Dr. Jacob Gould Schurman, President Cornell University, Ithaca, N. Y.; Henry R. Towne, Chairman Yale & Towne Manufacturing Co., New York City.

The contest is open without restriction to all persons except those who are members of or identified with the National Industrial Conference Board.

Contestants are not limited to papers of any length, but they should not be unduly expanded. Especial weight will be given to English and to skill in exposition.

The copyright of the prize manuscript, with all publication rights, will be vested in the National Industrial Conference Board.

Each competitor should sign his manuscript with an assumed name, sending his true name and address in a sealed envelope superscribed with his assumed name. No manuscript will be accepted the real authorship of which is disclosed when the manuscript is received by the board, nor any which has been previously published in any way.

Manuscripts, to be considered in the contest, must be mailed on or before July 1, 1919, to the National Industrial Conference Board, 15 Beacon St., Boston, Mass., marked "For Prize Essay Contest in Industrial Economics."

The right to reject any and all manuscripts is reserved. The board may, however, award honorable mention to several manuscripts and arrange for their publication in full or in part, at compensation to be agreed upon between the board and the authors.

License for West Virginia

PROVISIONS of the bill now before the Senate of West Virginia are: That a boiler or engine of more than 50 hp. shall have a licensed engineer to operate it, with the usual exceptions of locomotives and plants under jurisdiction of the United States government.

With the approval of the Senate, the Labor Commissioner is to appoint a Chief Examiner, who must be a citizen of the state, with 10 yr. experience as a practical steam engineer. His term will be 4 yr.; he must be bonded for $3000, and is subject to removal for cause.

The state is to be divided into three districts, each with a district examiner who has had 5 yr. experience, is to be bonded for $2000 and to receive a salary of $2000 a year, with not over $1200 a year traveling expense allowed.

Subjects for examination for a license are: Construction and Operation of Boilers, Engines and Pumps, rules and regulations for the examination to be made by the chief examiner. Fees for examination are to be embodied in those rules.

Licenses are for 1 year to be renewed yearly. Sixty days is allowed for an engineer operating a plant to make application for examination.

Fines for violations of the law are to be $50 to $25.

TO HELP in starting commercial connections between the United States and Poland, and to collect data for the work of future Polish commercial agencies in this country, the Commercial and Industrial Bureau of the Polish National Department has been opened at 1032 Aeolian Building, 33 W. 42nd St., New York City. The Bureau will be glad to send to anybody interested information concerning trade conditions and business possibilities in Poland, and to assist individuals or corporations wishing to get in contact with the Polish market.

New Traveling Grate Stoker for Forced Draft

POWER PLANT designers have long sought a completely automatic stoker which can be forced far in excess of the limits of natural draft. The traveling and chain grate types have for some time met the automatic requirements, but there are certain conditions which must be complied with before the application of forced draft can be considered as commercially successful. Summarized, these requirements are as follows:

1. A quiet fuel bed during combustion, to avoid the formation of clinkers while the fuel is in a plastic state.

2. The intense heat resulting from the application of forced draft necessitates the removal of all refuse as it is formed so that an accumulation of ash will not fuse around unburned fuel.

3. All air spaces must be periodically and completely cleaned of clinker in order to ensure continuous and automatic operation.

4. The air supplied must vary during the different stages of combustion, requiring therefore variation in air pressure as combustion proceeds. During the coking process sufficient air must be supplied to burn the volatile combustible; this may or may not be the same per pound of fuel as required to burn the fixed carbon, depending upon the percentages of these constituents. When combustion is nearly completed, the fuel bed is largely ash and its resistance to the passage of air is greatly reduced; these conditions require a reduction in air pressure.

5. To avoid use of forced draft when load conditions permit, the furnace should be readily convertible to the natural draft type.

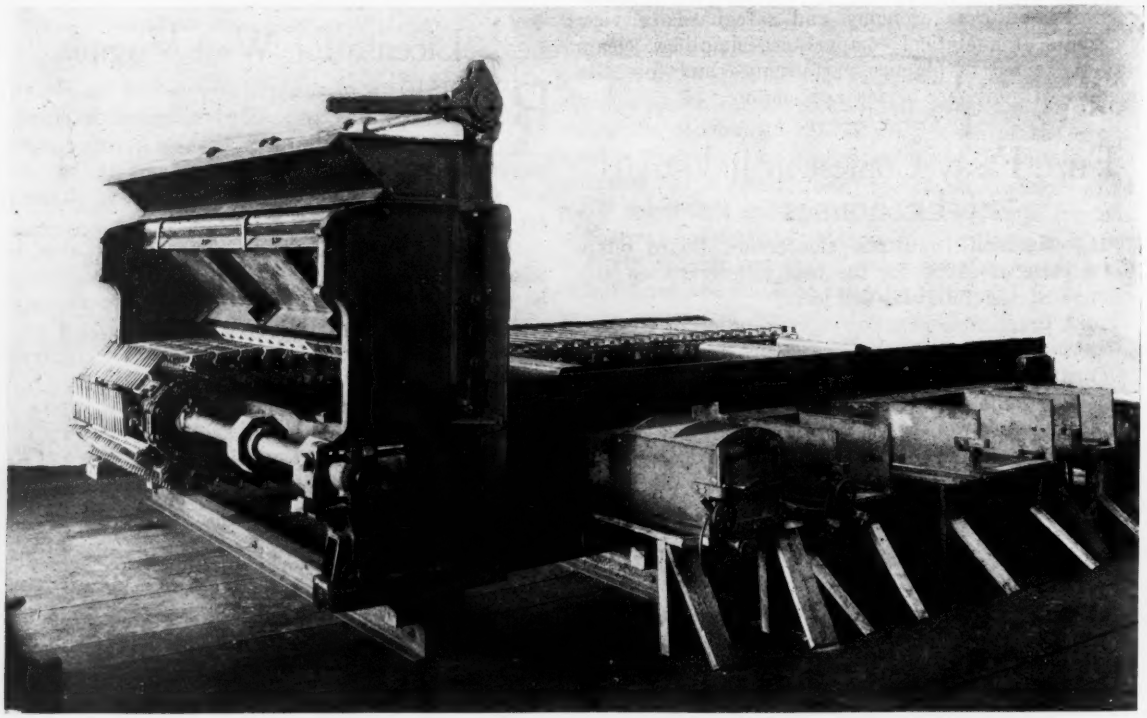


FIG. 1. VIEW OF PARTIALLY ASSEMBLED TRAVELING GRATE STOKER ARRANGED FOR FORCED DRAFT

6. Parts subjected to the heat and fusing action of direct fuel contact must be readily replaceable and subjected to no mechanical stress other than their own support and the support of their portion of the fuel bed.

With these principles in mind, Joseph Harrington has developed a traveling grate stoker which with modification in the amount of air space will, it is thought, be suitable to any grade of coal now in use in power plants from middle western screenings to anthracite and coke breeze.

In the design of this stoker, cast-iron side frames

carry the driving gear, hopper, front shaft and feed gate, as will be understood from the illustrations herewith. The side girders are formed of structural steel members, built like a truss, permitting stokers 20 ft. in length to be built. Transverse members of structural steel support a series of tracks on which run semi-steel chains, which carry and support the grate surface and take up the stress and tension of the chain. These are provided with V rollers to insure alinement both horizontally and vertically and to reduce the power required

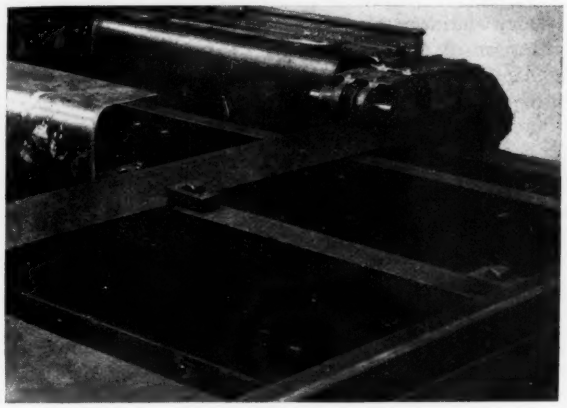


FIG. 2. CLOSE-UP VIEW OF CHAIN, BAR ROCKS AND GIRDERS AT REAR WITH SHIELDS TO PREVENT AIR LEAKAGE

to drive the stoker. Attached to these chains is a series of transverse racks or beams on which the clips or bars forming the grate surface are attached.

These bars, details of which are shown in Fig. 3, are sufficiently loose that they may be slid readily over the ends of the racks and prevent any rusting together of adjacent parts. The straight under surface of these racks makes possible a practically air tight diaphragm or seal between adjacent air compartments beneath the

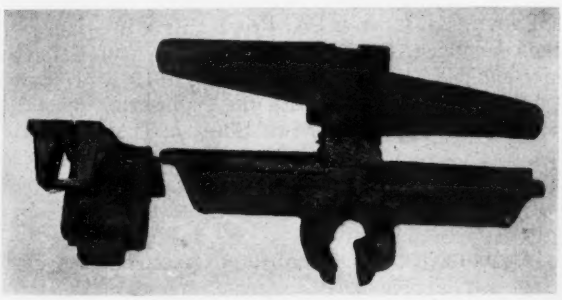


FIG. 3. VIEWS OF A NON-SIFTING GRATE BAR AND CROSS SECTION TO SHOW AIR SPACE

grate surface. These compartments, three in number, occupy the entire space between the chains communicating on one or both sides to the air duct in the side walls or below the floor of the boiler room. The entrances to the air compartments from the duct are provided with individual adjustable dampers by means of which the air pressure under each section of the grate may be regulated to suit the needs of the case. As may be seen in Fig. 1, the passages through the walls terminate in readily removable doors, which, when taken off, allow free access to the chamber for removing what dust may have fallen through the grate and also permit the use of natural draft when this seems advisable.

Close observation of Fig. 3 shows how these special grate bars prevent the sifting of coal or ash through the grate. By overlapping the edges of the bars a horizontal shelf is formed beneath the air space between grate bars and prevents the fuel from pouring through, at the same time air is forced up through this Z-shaped opening, tending to carry the fine particles back up into the fuel bed. A lug on this shelf prevents the complete closure of the air space and for the different grades of fuel the only change necessary is to provide grate bars with the proper proportion of air space. For middle western coal 20 per cent air space is recommended and for anthracite and coke breeze 10 per cent when forced draft is employed. It is expected that combustion rates as high as 75 lb. of coal per square foot of grate surface per hour can readily be obtained with this type of furnace.

The particular stoker illustrated here is designed for coke breeze and has grate surface 10 ft. wide by 13 ft. long, for a 500 hp. boiler. It will be driven by a variable speed engine through a double worm reduction gear attached to the rear shaft. The motion will, therefore, be continuous and the fuel bed will be carried forward at a uniform speed and without disturbance except that, due to its own combustion as a unit from beginning to end.

Forced draft at a pressure of 4 in. of water will be furnished by a fan with a capacity of 15,000 cu. ft. per min.

Loaders Serving Power Plant Needs

PROFITING by their experiences of last winter, many power companies, manufacturers and others have stored coal in large quantities during the past few months to meet any emergency that may arise this winter.

FIG. 1. COLLAPSIBLE LOADER, MOTOR DRIVEN, UNLOADING COAL DIRECT FROM HOPPER BOTTOM CAR

The storage pile is frequently located a considerable distance from the power house, necessitating the installation of some method of transporting and transferring the coal before it reaches the boilers. In many cases it

is not feasible to handle the coal from the pile to the boiler room by means of a conveyor or to cart it in wheelbarrows.

In such cases, the motor truck offers the most feasible method of transferring coal from the storage pile to the boilers, but on account of the scarcity and high cost of labor, shoveling it to truck or wagons by hand is out of the question.

The problem has been effectively solved by the Jeffrey Self-Propelling Loader which loads 1 to 1¼ tons of coal

FIG. 2. SELF-PROPELLING LOADER RECLAIMING COAL FROM STORAGE PILE

or coke, or 1 to 1½ cu. yd. of ashes, per min., doing the work of 5 to 10 hand shovelers.

This loader can be operated by one man, is practically fool-proof and will stand up under heaviest service. Too much stress cannot be laid upon the self-propelling feature of the Jeffrey loader, requiring the use of only one man to operate or move from pile to pile. The loader under its own power will dig into the pile and can be withdrawn simply by the operating

FIG. 3. HANDLING 8 YD. ASHES IN 8 MIN.

mechanism accessible at all times and within easy reach of the operator.

The collapsible boom is also an excellent feature, as it can be raised or lowered to suit conditions at the stock pile, and is also convenient in moving the machine from one stock pile to another or when it has to pass under trestles or low obstructions of any kind.

The illustrations show the adaptability of these loaders to meet all conditions of handling materials.

News Notes

MAGNOLIA METAL CO. announces the death, on Jan 14, 1919, of Edward C. Miller, Jr., who was a director of the company and manager of its smelter at Matawan, N. J.

AINSLIE A. GRAY has opened offices at 1547 Marquette Bldg., Chicago, under the name of A. A. Gray & Co. The firm will handle accounts in trade, technical and national magazines for advertising of a technical nature.

LESTER E. ARMSTRONG has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Co., of Chicago. Prior to his service in the Air Branch of the Army, Mr. Armstrong was associated with Babcock & Wilcox.

W. S. QUIGLEY, president of the Quigley Furnace Specialties Co., Inc., sailed for Liverpool on the Baltic, Feb. 15, to spend several weeks in England, France and Italy for the purpose of further developing European connections of his company.

H. W. JOHNS-MANVILLE CO. has decided, as a method of profit-sharing, that it will pay to each employe who served during the full calendar year 1918 a bonus of 20 per cent of his year's salary. This yearly bonus has been a custom, but the percentage is considerably larger this year than has been the custom.

JOHN F. NEALIS, who recently received his discharge from the Aero Observers branch of the service, is now associated with the Powdered Coal Engineering & Equipment Co., of Chicago, as advisory engineer. Mr. Nealis formerly had charge of research work for the U. S. Steel Corporation.

R. E. S. GEARE has been elected president of the Mid West Manufacturing Co., recently incorporated. Mr. Geare is well known to the construction and power plant field in Chicago and the middle west because of his active representation of the T. L. Smith Co., Manistee Iron Works Co., Geare & Co., and others, which work he will still continue.

FREYN, BRASSERT & Co., Peoples Gas Building, Chicago, announces the appointment of Wyman Eaton as chief engineer, taking effect Feb. 15, 1919. Mr. Eaton was formerly connected with the engineering offices of Julian Kennedy, Youngstown Sheet & Tube Co., Wm. Tod Co., Corrigan McKinney Co., and has recently resigned his position of engineer in charge of the rolling mill work of the Mesta Machine Co. to take up his new duties.

A NATION-WIDE campaign to put an end to the waste attributed to inadequate packing, wrapping and marking of express shipments has been inaugurated by the American Railway Express Co., which is handling the express business on practically all the railroads of the country. It is expected that by remedying this evil, it will be possible to bring about a marked improvement of the express service throughout the country.

BRITISH import prohibitions have again been put in force on a considerable list of materials, among which are included fire extinguishers, machine tools and power-driven machinery, for all metal and woodworking, machines for grinding, planing or moulding iron, sawing machines, slide rules, time recording instruments of all kinds, weighing machines, and all of these now require special license in order to send them to Great Britain.